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SCIENTIFIC SECRETARY TRAINING PROGRAM DEVELOPMENT.

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THE OBJECTIVES OF THE PROJECT, CONDUCTED DURING THE PERIOD SEPTEMBER 20, 1965, TO MARCH 15, 1968 WERE TO (1) DETERMINE THE EDUCATIONAL NEEDS OF THOSE PERSONS WORKING AS SCIENTIFIC SECRETARIES, (2) DEVELOP AN INSTRUCTIONAL PROGRAM TO MEET THESE EDUCATIONAL NEEDS, (3) CONDUCT A PILOT TRAINING PROGRAM TO TEST THE ADEQUACY OF THE INSTRUCTIONAL PROGRAM, AND (4) DETERMINE THE CRITERIA AND EVALUATIVE INSTRUMENTS FOR PREDICTING THE SUCCESS OF PERSONS TO BE TRAINED. EDUCATIONAL NEEDS WERE DETERMINED THROUGH A REVIEW OF LITERATURE, A SURVEY OF EXISTING SPECIALIZED SECRETARIAL TRAINING PROGRAMS, AND OBSERVATIONS, INTERVIEWS AND A QUESTIONNAIRE STUDY OF PERSONNEL IN 118 SCIENCE-RELATED ORGANIZATIONS IN 25 DIFFERENT STATES AND THE DISTRICT OF COLUMBIA. A PILOT TRAINING PROGRAM FOR 46 TRAINEES, CONSISTING OF 320 CLOCK-HOURS OF INSTRUCTION, BASED ON CRUCIAL TASKS IDENTIFIED IN THE STUDY WAS CONDUCTED AND EVALUATED. IT WAS FOUND THAT SCIENTIFIC SECRETARIES HAVE SPECIAL EDUCATIONAL NEEDS FOR DEVELOPING KNOWLEDGE AND SKILLS IN BASIC GENERAL SCIENCE, SCIENTIFIC AND TECHNICAL TERMINOLOGY, MATHEMATICS, TECHNICAL TYPING (EQUATIONS, SYMBOLS, AND FORMULAS), AND TECHNICAL SHORTHAND. THE TRAINEES ACHIEVED SIGNIFICANT IMPROVEMENT IN KNOWLEDGE AND SKILL ON 16 OF 20 PRE- AND POST-TEST MEASURES (.05 LEVEL) AS A RESULT OF THEIR EXPERIENCE IN THE PILOT TRAINING PROGRAM. IT WAS CONCLUDED THAT IT APPEARS POSSIBLE TO PREDICT WITH CONSIDERABLE ACCURACY THE DEGREE OF SUCCESS WHICH ADULT WOMEN WILL ACHIEVE IN A FORMALIZED TRAINING PROGRAM FOR SCIENTIFIC SECRETARIES. EXTENSIVE APPENDIXES INCLUDE CATALOG DESCRIPTIONS OF EXISTING TRAINING PROGRAMS, THE PROJECT EVALUATION, PROJECT DATA, AND CURRICULUM GUIDES FOR SCIENTIFIC SECRETARY TRAINING PROGRAMS FOR SECRETARIAL SKILLS, ENGLISH, MATHEMATICS, AND SCIENCE. (PS)

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SCIENTIFIC SECRETARY TRAINING PROGRAM DEVELOPMENT

March, 1968

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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SCIENTIFIC SECRETARY TRAINING PROGRAM DEVELOPMENT

Project No. BR5-0188

Contract No. OE-6-85-049

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March, 1968

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University of Colorado

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I

INTRODUCTION

Background of the Project

The impact of rapidly expanding scientific knowledge and its technological application presents a major challenge to education for the development of programs that will train competent persons to perform increasingly specialized and complex tasks in our modern science-oriented world. Secretarial education is no exception in the general trend toward greater specialty and complexity, as illustrated by the prior development of acceptable training programs to prepare persons for jobs as "medical" and "legal" secretaries.

By virtue of being located within a rapidly growing scientific complex (including basic research, engineering design, and commercial production) in the immediate Denver-Boulder area, certain faculty and staff members of the University of Colorado perceived a need for specially trained persons to provide secretarial services for scientists and engineers. Consequently, in May of 1965, these University staff members collaborated in the preparation and submission of a proposal to the U. S. Commissioner of Education, under the provisions of Section 4 (c) of the Vocational Education Act of 1963, for the development of an experimental program to train "scientific" secretaries. The proposal was subsequently approved to provide funds to conduct a research and development project during the period September 20, 1965, to March 15, 1968.

An Advisory and Supervisory Committee composed of University faculty and staff members was established to assist with the general planning and supervision of the project. Individually, the Committee members conducted and supervised those research and developmental activities appropriate to their respective special fields. Research and teaching assistants were appointed to assist Committee members in carrying out the several phases of the project. A part-time secretary was employed to provide required secretarial services.

Definition of the Problem

Briefly stated, the problem in this project was to determine whether or not there are special skills and knowledge required of the secretary working in a scientific setting and, if so, to determine whether or not an instructional program specifically designed to meet the specialized educational needs of scientific secretaries would, in fact, provide these skills and knowledge to persons with appropriate ability and motivation. Criteria for the selection of trainees who could successfully complete such an instructional program also were studied.

Objectives of the Project

In order to study the problem as defined above, the following objectives were established for the project:

1. to determine the educational needs of those persons working as scientific secretaries in relation to the requirements of their employers;
2. to develop an instructional program to meet the educational needs of scientific secretaries;
3. to conduct a pilot training program to test the adequacy of the instructional program, including a follow-up evaluation of the trainees' on-the-job performance; and,
4. to determine the criteria and evaluative instruments for predicting the success of persons to be trained for employment as scientific secretaries.

It was anticipated that, if successful, this experimental project would have at least the following beneficial outcomes:

1. it would assist interested and capable individuals to obtain specialized training which would enhance their employability as secretaries;
2. it would provide the impetus and guidelines for community colleges, area vocational schools, business schools, and related educational agencies throughout the nation to conduct similar programs to train scientific secretaries; and,
3. it would facilitate the work of scientists and engineers by providing them with specially trained and competent supporting secretarial services.

It is within this frame of reference that the various research findings, instructional materials, conclusions, and recommendations which have resulted from this project are set forth in the ensuing sections of this report.

II

METHOD

Determining the Educational Needs of Scientific Secretaries

Review of related literature.

The review of related literature was planned to meet three objectives: to determine the current thinking (as revealed in periodical literature) of educators and leaders in science-related industries concerning the work and training of the scientific secretary; to find an authoritative study of general secretarial skills and traits to use as a basis on which to build the skills of the scientific secretary; and to determine if the curricula of secretarial training programs in other specialized areas might provide guidelines in constructing a curriculum for scientific secretarial training. The review of literature was limited, with one exception, to what has been published in the last five years.

Current thinking of educators and leaders in science-related industries regarding the work and training of the scientific secretary. There has been very little published about the work and training of the scientific secretary. Veon said:

> It has been found that a real shortage lies in the area of technical aides or assistants or secretaries. If engineers and scientists have to assume so much of their paperwork, it is quite obvious that there is a great loss of vital research. If the secretary is competent to assume much of this paperwork, and if he is interested in science and engineering problems, he will find that because of the demand and the fact that there are so few qualified individuals for this job, he will work up the ladder to a position in the bracket of middle management.[1]

Veon continued:

> The technical secretary will have new duties to perform as well as to master present duties more skillfully. This person must have not only an interest in science but also at least a good general background of scientific knowledge. This will enable the secretary to handle scientific and

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[1] Dorothy H. Veon, "Secretarial Education with a Future," Business Education Yearbook 1962, Chapter 1, pp. 6-7.

> technical terminology in performance of duties. A mastery of mathematics through calculus is advantageous. Special training will be needed in advanced shorthand and transcription to adapt to special problems relating to taking scientific dictation. The individual must also be a master of statistical typing required by scientists and engineers. Basic knowledge of chemistry and physics are desirable. Preparation should be supplemented by excursions to such places as chemical plants, airline installations, scientific institutions, and atomic power plants.[1]

The Science-Engineering Secretary, a reference book which was written by Stafford and Culpepper to assist the technical secretary, is based on experience acquired by both authors at the RAND Corporation, Santa Monica, California, and at Thompson Ramo Wooldridge, Inc., Los Angeles. In the preface of this book the authors commented:

> Today's science-engineering secretary and typist is a specialist in a group of specialists. Her skills are varied. She must be expert at handling the voluminous paperwork necessary in a world where Science creates, Engineering adapts and develops, Industry produces. Such an environment has created a new language of science and technology, as well as new office procedures, typing techniques, and technical specialties.[2]

Putney suggested that more schools should be making surveys of their communities to see if they are meeting industry's need for technical secretaries; and she described a survey underway at Rochester Institute for this purpose.[3]

Kurtz, who has helped to develop a successful technical secretarial training program at Colby Junior College, New London, New Hampshire, reported on that program in the March, 1964, issue of The Journal of Business Education. She said that Colby's survey of industry previous to the beginning of the program there emphasized the need for college-trained technical secretaries.[4]

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[1] Ibid., p. 9.

[2] Alison R. Stafford and Billie Jean Culpepper, The Science-Engineering Secretary, (Englewood Cliffs, N. J., Prentice-Hall, Inc., 1963) p. v.

[3] Agnes Putney, "Meeting Industry's Needs for the Technical Secretary," Business Education World, March, 1965, p. 65 and 68.

[4] Margaret A. Kurtz, "Who Should Train Technical Secretaries--Industry or Educators?" The Journal of Business Education, March, 1964, pp. 230-232.

Authoritative study of general secretarial skills. A complete survey of basic secretarial skills and traits was needed to use as a basis on which to build the skills and traits necessary for the scientific secretary. Analysis of Secretarial Duties and Traits, by Charters and Whitley,[1] presented the most complete survey. Since the findings of the survey appeared to be still valid today, this study was chosen for use in the present study even though the book was not published recently.

Curricula of secretarial training programs in other specialized areas. Course offerings of a random sample of legal and medical secretarial training programs were examined to see if guidelines might be discovered for use in developing the scientific secretarial training program.

Letters were sent to 100 schools, selected randomly from the complete listing in a national directory of schools offering legal and medical secretarial training. The letters requested catalogs, course descriptions, and any additional information that the schools felt would be pertinent. Over fifty schools responded by sending bulletins and catalogs which were analyzed.

Survey of existing training programs for the scientific secretary.

Names of schools and colleges offering any kind of technical secretarial training were sought in national directories and in the periodical literature. Letters were sent to 24 schools which were described as having some training for the scientific secretary. Included were schools which listed training for "technical," "engineering," "electronics," "scientific research," "engineering-science," "automation," and "aviation" secretaries.

The responses to the request for information indicated that two schools had cancelled their programs, one school had no one enrolled in the program, and in one school there was still doubt about the future of the program at that institution. However, eight schools sent catalogs and/or course descriptions which contained information of some relevance to the development of this program. (For a summary of the course offerings of these schools, see Appendix A.)

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[1] W. W. Charters and Isadore B. Whitley, Analysis of Secretarial Duties and Traits, Baltimore, Maryland, Williams & Wilkins Company, 1924.

Development of interview and questionnaire instruments.

The initial questionnaire items were obtained from two sources. Those items pertaining to the normally expected secretarial tasks and skills were selected from prior studies in this field. Those items concerning the special tasks and skills required of secretaries working in a scientific setting were developed through observations, interviews and study of job descriptions, and by reading the available literature related to the scope of special tasks and abilities which scientists require of their secretaries. The critical incident technique as developed by John C. Flanagan[1] was used in the construction of each instrument. The questionnaire was designed to collect specific incidents of effective and ineffective behavior in respect to the scientific secretarys' job. These initial items were compiled in a preliminary questionnaire, including pertinent personal data concerning the respondent, for trial use with scientific secretaries. Similar procedures were followed in developing questionnaire items for the instruments to be used with scientist supervisors and personnel managers which would elicit the same basic information, although differing in format and extent of detail. These preliminary questionnaires were evaluated by using them both as interview and written response instruments with 69 secretaries, 22 scientist supervisors, and 21 personnel managers in 43 different science-related organizations readily available in the Boulder and Denver metropolitan area. The face validity of the instrument and lack of confusion on the part of the secretaries, supervisors, and personnel managers in their responses to the preliminary questionnaires was accepted by the Committee as indicative that the instruments did obtain the desired data effectively and on a consistent basis. Some minor modifications in items and format were made, primarily to facilitate completion of the questionnaires and the tabulation of the data.

Selection of organizations and individuals for interviews and questionnaires.

The Committee agreed that the population to be surveyed should be as representative as possible with respect to: 1) the kinds of organizations employing scientific secretaries; 2) their major fields of scientific endeavor; and 3) their geographic location.

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[1] John C. Flanagan, "The Critical Incident Technique," Psychological Bulletin, Vol. 51, No. 4, July, 1954.

On this basis a list of 542 different organizations was compiled from national directories, representing the following major fields of scientific endeavor in the approximate proportions indicated:

Aerospace	17%
Biology and pharmaceuticals	7%
Chemistry	15%
Earth science and oceanography	8%
Mathematics, computers and controls	14%
Physics and electronics	15%
Technology (unclassified)	24%

In addition, a list of 43 science-related organizations located in the State of Colorado was compiled to serve as the immediately available population for observations, interviews, and preliminary testing of the questionnaire.

The Committee further agreed that, in order to broaden the base of questionnaire responses, it would be necessary to seek data from three categories of persons familiar with the crucial tasks and critical qualifications of scientific secretaries; namely: 1) secretaries currently working in the scientific setting, 2) scientists currently supervising such secretaries, and 3) personnel managers responsible for employment, training and evaluation of performance of scientific secretaries.

Final application of interview and questionnaire instruments.

Letters with return postcards were sent to the 542 selected organizations on the nationwide list, requesting their cooperation in responding to the questionnaire. Of the 218 responses received, 121 were affirmative. After reviewing the nature of these 121 organizations, the Committee sent additional letters of inquiry to eight governmental agencies and ten educational institutions in an effort to increase their representation in the sample. Affirmative responses were received from four additional governmental agencies and one educational institution.

The revised final questionnaires (see Appendix B) were submitted to the U. S. Office of Education and, upon approval, were mailed to 363 secretaries, 199 scientist supervisors, and 107 personnel managers of the 126 organizations agreeing to participate in the study. Follow-up of non-responding organizations was initiated after eight weeks had been allowed for response. A cut-off date of April 30, 1966, was established for inclusion of responses to be used in the analysis of the data for determining the critical tasks and corresponding skills and knowledge on which the curriculum for the pilot training program would be based. By that date, responses were received from individuals in 61 science-related organizations in 25 different states and the District of Columbia. Subsequent to the cut-off date, responses were received from individuals in an additional 14 scientific organizations. Thus, the final total of responses received from secretaries, scientists, and personnel managers represented 118 different scientific organizations (including the 43 Colorado organizations in the preliminary, trial run).

Curriculum Development

The scope of the task in developing the curriculum for the pilot training program included the following functions:

1. formulation of objectives for the instructional program;

2. determination of course content appropriate to the trainees' capabilities and the knowledge and skills to be learned;

3. preparation and selection of instructional materials;

4. determination of instructional methods and techniques to be utilized;

5. determination of a satisfactory time schedule for the instructional program; and

6. provision for evaluation and modification of the curriculum as the training program progressed.

In order to carry out these functions, it was necessary to determine the crucial skills and knowledge required of scientific secretaries as identified through the critical incident technique. Curriculum objectives were formulated on the basis of the critical incidents and were categorized according to major areas of instruction to establish the scope of the curriculum.

The course content in each of the major areas of instruction also was determined on the basis of the identified crucial tasks. The level of instruction (i.e., degree of difficulty) was established on the basis of the level of educational attainment of the scientific secretaries who participated in the questionnaire survey and interviews and, also, the responses of scientist supervisors and personnel managers.

Available published instructional materials in the major areas of instruction were reviewed and selected with respect to their appropriateness to the curriculum objectives, course content, and level of instruction. Original instructional materials were prepared by the project staff in lieu of or as supplementary to published materials, as required. Actual copies of correspondence, reports and records currently being produced in the offices of scientific organizations also were reviewed and selected or adapted for use as instructional materials.

The methods of instruction were determined in accord with generally accepted principles in the field of adult education. Specific instructional techniques were selected on the basis of the degree of experiential abstraction of course content and the required degree of student participation in the particular learning activity.[1]

The schedule for the pilot training program was determined on the basis of the estimated total of clock hours of class instruction and skills practice required to complete the course content in each of the major areas of instruction, arranged in weekly blocks of time found to be most convenient through a survey of the prospective trainees.

Preliminary curriculum guides, incorporating objectives, content, methods and materials, for each of the major areas of instruction were prepared by the project staff. Provision was made for subsequent evaluation and modification of these preliminary curriculum guides based on data obtained from: 1) an analysis of the characteristics of the selected trainees; 2) an analysis of the pre-test results; 3) periodic teachers' evaluation of the trainees' achievement; and, 4) an analysis of the trainees' responses to evaluative questionnaires administered at midterm of the pilot training program (December, 1966).

Recruitment and Selection of Trainees

In response to newspaper publicity and notices which were sent to scientific organizations and agencies in the Denver-Boulder area, over eighty persons made application for admission to the pilot program, and eventually forty-six were accepted. During the initial screening, applicants were separated into three groups--acceptable, unacceptable, and questionable. At first "acceptable" ratings were given only to applicants who, in addition to being high school graduates:

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[1] cf., Coolie Verner, A Conceptual Scheme for the Identification and Classification of Processes for Adult Education, Adult Education of the U. S. A., Washington, D. C., 1962, pp. 13-29.

1. had marketable skills in typing and shorthand;
2. had some experience in scientific secretarial work or a good high school or college background in science and mathematics;
3. gave evidence of above average capability and intelligence; and,
4. gave evidence of career commitment, motivation, and continuing interest in the program.

Later in the selection process it became necessary to modify these criteria somewhat in order to balance the group of selectees and keep it as representative as possible of the different kinds of people who might be taking the course in the future. Thus, some applicants with less secretarial experience or science background were accepted while others more experienced and skilled were rejected. Similarly, some applicants were rejected because they were within an overly-represented age group. However, selection criteria with regard to intelligence and motivation remained unchanged, as these attributes were considered necessary for the successful completion of the course. In a few instances, personal references were obtained to clarity and substantiate the qualifications of applicants.

An attempt was made to select trainees who represented a reasonably broad range of experience, talent, and personal characteristics. The wide variety of trainee qualifications was considered important in the predictive study based on the pilot training program. However, no one was selected who was considered incapable of completing the pilot project successfully. The Committee selected a number of trainees without scientific background or current scientific employment because it was felt that these trainees were representative of persons who would take the course in the future.

Evaluation of the Pilot Training Program

The research design for evaluating the effectiveness of the pilot training program consisted of four parts; namely: 1) pretest and post test procedures, 2) teachers' evaluations of trainees' progress, 3) trainees' evaluation of the training program, and 4) the trainees' work supervisors' evaluations of the training program.

Selection, preparation, and use of pretest and post test instruments.

A review of the relevant literature in the field indicated that, although many studies had been carried out, very few obtained results that were directly relevant to the Scientific Secretary Training Program (SSTP). No single test instrument or test battery was found to be dominant in the field and no study was found to be identical or parallel with the SSTP proposal. Those test instruments that appeared most promising were secured and carefully evaluated by the Committee and the instructional staff to determine their appropriateness for the SSTP. Certain standardized tests were thought to be useful or at least worthy of experimentation. In the area of secretarial skills, science and mathematics, no complete sets of standardized tests were found that were relatively short and still covered the curriculum content areas in an appropriate manner. Thus, it became necessary to select certain standardized tests and to prepare from materials available other appropriate tests to form a complete battery. Where possible the project staff selected materials that had been used before and reworked them into the pretest and post test format. For the shorthand transcription test this was a relatively straightforward process that involved selecting appropriate content and setting time limits. The science test was composed of questions that were related to the curriculum content and to the amount of time and emphasis given each scientific field in the proposed curriculum outline. The mathematics test was prepared to evaluate two levels of performance. It was recognized that secretaries generally were not well trained in advanced mathematics and that their responsibilities usually required them to handle only relatively simple arithmetic problems. Consequently, a list of fifteen basic but somewhat difficult mathematical problems were used to evaluate this level of performance. The second level of mathematics testing consisted of a list of symbols and terms judged to be appropriate to the proposed mathematics course content.

The pretest and post test battery was administered on the first two days and again on the last two days of class. Parallel forms of the tests were used where available. No information on individual results was given to the trainees or the instructors, although the instructors were informed of the general areas of weakness, identified by the pretest battery.

The pretest battery contained the following standardized and locally constructed tests:

Minnesota Clerical Test

Cooperative English Expression Test, Form 1A

DAT Language Usage Test, Form A (spelling and sentences)

A twenty minute typing test (Appendix C)

A thirty minute shorthand transcription test (Appendix C)

A mathematics test consisting of 15 locally constructed pre-college questions and problems, and a selection of vocabulary terms in the identification of mathematical expressions (Appendix C)

The post test battery included basically the same tests, with Form 1B of the Cooperative English test and Form B of the DAT test being used. The locally constructed tests were repeated in the same form as part of the final examination in each section. The Minnesota Clerical Test was not repeated in the post test battery since it was intended primarily for descriptive purposes rather than measurement of achievement.

The possible limitations of using a locally constructed test as a pre and post measure of performance were recognized but it was felt that the benefit derived from an instrument specifically oriented toward the content of the curriculum warranted such procedure since none of the available standardized instruments were found to cover this content adequately.

In addition to the pre and post measures of achievement, a test battery designed to describe each participant in the pilot program along general ability and personality dimensions was chosen. The test battery selected consists of a slightly modified version of the Wechsler Adult Intelligence Scale (WAIS) which has been researched and related to the Personality Assessment System developed by Dr. John Gittinger and published in part in research articles by Dr. David Saunders. This test appeared to be the most appropriate instrument available for a detailed analysis of the trainees and the collection of data used to differentiate the characteristics of the successful and non-successful trainee in the pilot program. The WAIS was administered during the second month of the pilot training program and was not repeated since its purpose was to provide information describing each individual in the program as well as the certain subgroups and to develop a method for predicting performance of future participants in similar programs.

Teachers' evaluation of trainees' progress.

The teacher's responsibility was divided into two major sections. The first consisted of their daily class record of attendance and performance on in-class tests. The class record form was developed primarily for the use of the teacher in individual consideration, the teaching of trainees, and to give a basis for later ratings and evaluation. The second responsibility of the teachers was to rate each of the trainees in regard to the top, middle, and bottom third of their class and give evaluative and anecdotal comments for the trainee file. The first ratings were secured at the midterm of the program and repeated again at the end.

At the completion of the Scientific Secretary Training Program each trainee was rated by each teacher on a number of criteria including their level of achievement, degree of improvement, degree of interest, and the general impressions they made. (see Appendix D for the rating form.)

Trainees' evaluation of the pilot training program.

An evaluation questionnaire was constructed and, after review and revision by the Committee, was distributed to the entire group of trainees at midterm in December, 1966, at the close of the training program, June, 1967, and again in December, 1967, six months later. The trainees were asked to be as honest as possible in expressing their views concerning the effectiveness of the program. Tallies were made of the quantifiable data, and the open-ended questions were categorized and tallied. The instrument used for this evaluation has been placed in Appendix E and consists of several specific questions to which the trainee responds with an E for excellent, S for satisfactory, or U for unsatisfactory. Wherever U was used, the trainee was asked to explain. The evaluation form was repeated three times and the responses were anonymous. A rating scale for evaluating the curriculum objectives also was constructed and was used in the June, 1967, and December, 1967, evaluation procedures. The evaluation questionnaire and the curriculum objectives rating scale were used as interview instruments with those trainees who were working in a scientific setting in December, 1967.

Supervisors' evaluation of the pilot training program.

Evaluation questionnaires were constructed and sent to the work supervisors of the trainees in March, 1967, for information regarding the trainee's title and job responsibilities, dates of employment, whether changes in benefits or responsibilities had occurred and whether the training program was responsible for any such changes. Also asked were questions concerning changes noted in various aspects of the trainee's on-the-job performance since being in the program. Additional questions asked for program recommendations and for information regarding employment opportunities for scientific secretaries within the supervisor's company and whether there were other secretaries within the company who could benefit from the program. The supervisors also were sent a rating scale which listed the program's specific curriculum objectives in each of the four instructional areas. They were asked to indicate how well they thought the program was meeting these objectives, basing their judgments on the job performances of the trainees in their employ. The evaluation questionnaire was used again in December, 1967, as part of the follow-up evaluation of trainee progress. Because of the criticalness of the final evaluation, it was considered essential to use personal interviews with the supervisors of those trainees working in a scientific setting.

The supervisors were quite busy and not aware of the details of the Scientific Secretary Training Program and their responses were sometimes limited, as might be expected. However, their involvement and their judgment were valuable both in March of 1967, and again in December of 1967. (See Appendix F for the supervisors' evaluation form.)

The Predictive Study

Five steps were used to develop the prediction equations and the recommendations for the selection of future trainees.

First, data concerning the trainees were carefully analyzed and described in order to determine the trainees' characteristics and the effect of the pilot training program on the trainees' performance. The analysis was based on the data gathered from the trainee application form, the pretest and post test procedure, and the teachers' evaluations of the trainees' achievement.

Second, six outcomes of the training program were selected as criteria for the prediction study; namely:

Trainees' final achievement rating based on instructor ratings and post test results.

Length of time trainees persisted in the project.

Improvement in secretarial skills.

Improvement in English.

Improvement in science.

Improvement in mathematics.

Third, the trainee application form and the pretest and post test data were related to the six criteria listed above by Pearson and multiple correlation coefficients as well as "F" and"t" tests of significant differences derived from an analysis of covariance statistical procedure.

Fourth, the above relationships were used in a regression analysis carried out to establish the beta weights used in the regression equation.

Fifth, a set of qualifications and a test battery were identified and recommended as guide lines in the selection of trainees likely to benefit most from the training received in the pilot training program.

Treatment of the Data

The research design required considerable data processing. It was found necessary to punch the data into cards and use computer programs for analysis.

The first phase of the analysis was primarily descriptive, involving the tallying of responses, ranking and reporting of appropriate percentages. Data obtained from all questionnaires, application forms, rating instruments, and tests were treated in this manner.

The second phase of analysis was comparative wherein correlations or tests of significant differences were run.

The third phase of analysis was predictive and consisted of multiple correlation and multiple regression analysis studies.

Thus, the treatment of data permitted a number of evaluative observations and analyses to be made as the pilot training program was being developed, while it was being carried out, at the end of the training program, and after the follow-up study was completed.

III

RESULTS

Identification of Educational Needs of Scientific Secretaries

Findings from the review of related literature and the survey of other secretarial training programs.

Current thinking of educators and leaders in science-related industries regarding the work and training of the scientific secretary. Everyone writing on this subject was in agreement that a new type of secretary is emerging in science and technology, and this secretary needs to learn many things which are not taught in the standard secretarial training program. If the secretary can gain some of this knowledge before beginning the job, the time spent learning on the job can be reduced and the secretary can quickly become a productive member of the organization. There is a growing awareness among educators in this field that the schools should be conducting surveys and working with scientific industry to determine the possible need for training programs for the scientific secretary.

Authoritative study of general secretarial skills and traits. The study by W. W. Charters and Isadore B. Whitley, *Analysis of Secretarial Duties and Traits*, was selected by the Committee for use in constructing instruments to survey personnel directors, supervisors of scientific secretaries, and secretaries in scientific settings. Table 10, "Frequency ranking of 871 duties," and Exhibit M, "Vocational traits for secretaries," were used in the present study.

Curricula of secretarial training programs in other specialized areas. Analysis of the bulletins and catalogs from schools offering training for the medical and/or legal secretaries resulted in two findings relevant to the present study. First, most of these programs require at least two semesters of specialized training beyond the acquisition of basic secretarial skills; and second, many of the schools indicated that acceptance into the special training program is partly determined by better-than-average ability as indicated by high school grades.

Existing training programs for secretaries working in a scientific setting. An analysis of the school catalogs and literature received concerning existing training programs for the scientific secretary showed that most of the schools have narrowed their training to preparation for one area of science or technology, often to a training program for engineering secretaries. Several responses received from officials of these schools indicated feeling that they are successfully fulfilling the need for engineering secretaries in their communities; that industry is pleased with the training their students receive; and that the graduates are commanding higher-than-average beginning salaries, with good opportunities for promotion.

Officials of three schools responded that they have developed programs for training the scientific-technical secretary and that they have had these programs in operation for two or more years. One of these schools, Bryant and Stratton Business Institute, Inc., Buffalo, New York, selects students for its program on the basis of high school grades, an aptitude for mathematics and English, and above-average ability. Before specialization, all skills are developed, with ability to take shorthand at 100 to 110 words per minute, and to type at least 50 words per minute. In addition to a course in Technical Dictation and one in Technical Typewriting, students must take "Science of Mathematics and Blueprint Reading" and "Report Writing."

The program which is currently offered at Cerritos College in Norwalk, California, is based on the program developed at Colby Junior College, New London, New Hampshire. Research for the technical secretarial program at Colby began in 1958 when members of the Secretarial Science Department determined the need for such a program through a survey of industries engaged in research and development. In addition, they mailed a questionnaire to Colby alumnae working in similar industries, and they interviewed personnel in technical industries in the Boston area. After Colby teachers satisfied themselves of the need for such training, they introduced a program in technical secretarial training in the fall of 1959. In their program, courses in chemistry and physics from the regular college offerings are required, and mathematics is recommended. Then, in addition to the standard subjects for secretarial students at Colby, students in this specialized training take "Technical Dictation and Transcription," which includes understanding of terminology as well as writing and transcribing technical shorthand. Technical typewriting is developed in this course as an aid to transcription.

Miss Margaret Kurtz and Miss Dorothy Adams have developed special materials for teaching technical dictation and transcription. Arrangements were made with the authors and with the publisher, McGraw-Hill, to use portions of this material, which was still in preparation for publication, in the pilot training program at the University of Colorado.[1]

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[1] Dorothy Adams and Margaret Kurtz, The Technical Secretary: Terminology and Transcription, Gregg Division, McGraw-Hill Book Company, New York, 1968.

Description of the respondents and non-respondents to questionnaires and interviews.

The following tabulations describe the secretarial and managerial respondents and non-respondents to the survey in regard to the kind of scientific organizations and their geographic locations:

Number of Organizations

Respondents	118
Non-Respondents	41
Total	159

Number of Secretary and Management Returns

	Non-Respondents	Respondents
Secretary	103	198
Management	93	170
Totals	196	368

Type of Organization

	Non-Respondents	Respondents
Educational	2	22
Government	2	14
Industry	35	82
Unknown	2	0
Totals	41	118

Geographic Area

	Non-Respondents	Respondents
East	14	23
West	5	10
Central	15	24
Colorado	7	61
Totals	41	118

Scientific fields included in the study.

Scientific Field	Frequency of Non-Respondents	Frequency of Respondents	Percent of Total	
			(Non-Resp.)	(Resp.)
			%	%
Aerospace	3	19	1.7	10.5
Architecture	-	1	-	0.6
Astronomy	1	2	0.6	1.2
Biochemistry	1	1	0.6	0.6
Biology	-	5	-	2.8
Chem. Engineering	7) 10	7) 20	5.5	11.0
Chemistry	3)	13)		
Civil Engineering	-	2	-	1.2
Cryogenics	1	2	0.6	1.2
Electrical Engin.	-	6	-	3.3
Electronics	8	14	4.4	7.6
Engineering	8	10	4.4	5.5
Forestry	-	1	-	0.6
General Research	1	9	0.6	5.0
Geology	-	1	-	0.6
Math	-	2	-	1.2
Mechanical Engin.	-	6	-	3.3
Medical Sciences	-	2	-	1.2
Metallurgy	-	6	-	3.3
Mineralogy	1	5	0.6	2.8
Oceanography	1	-	0.6	-
Physics	3	15	1.7	8.3
Radio Communication	2	4	1.2	2.4
Technology	4	4	2.4	2.4
Totals	44	137	24.9%	76.6%

The preponderance of employment opportunities in private industry was represented proportionately in the survey. The large number of returns from governmental agencies and educational institutions located in Colorado was due to the size and importance of the many science-related governmental activities readily available in the Boulder-Denver area and the willingness of the University of Colorado's science departments and research units to cooperate in the study.

The major fields of scientific interest were identified and reported by the respondents. Some respondents listed two or more major fields of scientific interest which accounts for a seeming discrepancy in totals.

The comprehensive nature of the obtained sample was considered adequately representative of the work setting wherein scientific secretaries are employed. The non-respondents also were tabulated and evaluated to verify the representativeness of the obtained sample.

Findings from interviews and questionnaires.

The interview and questionnaire information was found to be very similar and was combined for this analysis. All responses were tabulated and are presented in Appendix G. An examination of the combined results from the preliminary run, final run, and after the cut-off date indicates that the most prominent products of the respondents were related to research, chemistry, electricity, and missiles. Aerospace, physics, and chemistry were the most frequently mentioned fields of study or industry. The number of industrial organizations far outnumbered all other types of organizations, and applied research far outnumbered basic research. The responses came mainly from large organizations with several thousand employees and many secretaries. Stenographic pools were not used in most of the responding organizations. The secretaries who responded had an average age of 40, were experienced in secretarial work, and somewhat over half of them were married. Very few of the secretaries were college graduates although ten reported being overtrained, and only nine thought they were undertrained.

With respect to the nature of specialized tasks and training required, the 198 secretaries working in a scientific setting reported the following in Table I:

1. The most helpful courses were typing, shorthand, and English.

2. They wished they would have taken more courses in chemistry, general mathematics, foreign language, physics, general science, advanced mathematics, English and shorthand. Many secretaries reported that they had taken some of these courses, and generally they enjoyed them.

3. The most crucial tasks and skills required of secretaries according to their own report were fast and accurate typing, shorthand, technical typing, English, scientific terminology, telephone duties, office management, and filing.

4. When asked what changes in their skills and knowledge would make them more ideal secretaries in their present positions, they expressed preference for technical knowledge, science, scientific terminology, and fast and accurate typing.

5. The advantages of specialized training were seen as

increasing their knowledge of science and scientific terms and their ability to set up tables and graphs.

TABLE I

SUMMARY OF SECRETARIES' RESPONSES

Courses and Tasks	Crucial Tasks	Crucial Skills	Change to be Ideal	Advantages	Most Help	Wished for
Fast and accurate typing	58	80	15		123	11
Shorthand	58	59			97	
Technical typing	43					
Telephone duties	28					
Office management	27					
Filing	18					
Basic sec. skills		25			27	
Understanding job		25				
Scientific terms		25	13	52		
More science			17	12		
Technical knowledge			21			
English		65			82	12
Set up tables, graphs				11		
Chemistry					10	34
General Mathematics						27
Foreign language						22
Physics						21
General science						17
Advanced mathematics						12

The job activities most frequently performed by scientific secretaries were those which also would be normally expected of secretaries working in a non-scientific setting. Such job activities as typing routine material, keeping ordinary files, taking dictation, and routine telephone duties were identified as daily tasks by more than two-thirds of the respondents. Certain specialized tasks associated with the scientific nature of the employer's enterprise were also performed frequently by these secretaries. Such tasks as keeping current research files, taking technical dictation, typing mathematical and scientific equations and proofreading from technical copy were daily job activities for more than twenty per cent of the secretaries and were performed one or more times a month by another forty per cent of the respondents.

A comparison of the secretaries' and personnel managers' responses concerning the type of training and courses which would best prepare a secretary for work in the scientific setting recalled the following:

Training and Courses	Per Cent of Secy's	Respondents Pers. Mgrs.
	%	%
Scientific and technical terms, abbreviations and symbols	42	41
English	28	29
Basic science	24	23
Basic secretarial skills	19	27
Mathematics	24	16
Technical typing (equations, symbols, Greek letters, formulas, etc.)	17	13
Chemistry	20	--
Technical shorthand	11	--

A summary of the recommended training courses and the frequency of responses are presented in the following table:

TABLE II

RECOMMENDED COURSES

Recommended Course	Secretaries	Supervisors	Personnel Managers	Total
Science and tech. terms	57	12	26	95
Basic science	31	17	15	63
English	34		18	52
Mathematics	31		10	41
Technical typing	27		9	36
Technical shorthand	17		18	35
Chemistry	23			23
Basic secretarial skills	21			21
Understanding business		4	5	9
Understanding research			8	8
Business Administration		4		4

When the secretaries were asked to identify the particular areas where further study of science would be of value to them in their work, they responded as follows:

Area of Further Study in Science	Per Cent of Respondents
General scientific terminology	58
Mathematical expressions and symbols	54
Technology	54
Engineering	49
Specific scientific terminology	40
Physics	34
Chemistry	33
Electronics	29
Computer science	19
Aerospace and astronomy	8
Earth science	8
Oceanography	6
Biology	5

Only nine secretaries reported a job title of "technical" secretary, and one reported a job title of "research" secretary. When the responses of these ten secretaries were compared with those of the rest of the sample, very few discrepancies in reported data were noted. Rather, the responses of these ten secretaries tended to support and emphasize more heavily the particular areas of desired training, crucial tasks and crucial skills mentioned by the remainder of the sample.

Specifically, these ten secretaries placed considerably greater emphasis on training in basic science, mathematics, mathematical expressions and symbols, technical shorthand and engineering. In addition, general science terminology, specific terms in the secretaries' scientific areas, technology and computer science were mentioned more often as valuable areas of further study. The technical secretaries also expressed a considerably stronger need for previous course work in general science and felt, more than the rest of the sample, that one of their weakest areas was technical vocabulary. In regard to the tasks rated by the secretaries as those most crucial to their jobs, the technical secretaries, compared with the rest of the sample, mentioned technical typing at least twice as often and filing about four times as often. The crucial skills mentioned at least twice as often were typing, shorthand, and English, while technical terminology was mentioned four times as often, and filing also was given heavy emphasis.

When a detailed breakdown of specific filing tasks was considered, very little difference was apparent in the filing activities of the ten technical secretaries compared with those of the rest of the group. In regard to organizing and analyzing data, again the difference was small, but the technical secretaries appeared to function in this area somewhat more frequently than did the remainder of the sample.

Most of the supervisors surveyed were scientists in administrative and management positions. In reporting their secretaries' job activities, frequent mention was made of the routine secretarial and administrative tasks, such as typing, filing, telephone duties, taking dictation, and general office management. However, the most frequently named single activity was technical typing and, when asked what further training they would like their secretaries to have, the supervisors most often recommended training in basic science and in technical terminology and symbols. A comparison between the secretaries' activities checked by supervisors as "ideal" and the secretaries' actual job activities showed a strong desire by the supervisors for more secretarial help in the areas of organizing and analyzing data. Two activities in particular were emphasized by the supervisors: 1) assembling data for supervisors' use in reports, conferences, and research projects; and 2) making calculations from or preparing graphical representations of technical or statistical data.

In general, the qualifications of a good scientific secretary were reported by their scientist-supervisors to be similar to those of any other secretarial position with the addition of specialized training in both science and the use of technical terminology.

Program Evaluation

Findings from pre and post testing procedure.

The results of the pre and post testing procedure are presented in Table III . The table includes data concerning the dropouts test scores. However, all comparisons of test data were based only on the 34 trainees who completed the training program so that the dropout data did not influence the gains achieved.

The data indicates that sixteen of the twenty pre and post measures reached at least the .05 level of significant improvement. The most dramatic change occurred in the fantastic reduction of mean percentage errors for ten minute rough draft typing from 00.60 to 00.09. A 94.6 percent improvement was achieved in chemistry (pretest mean = 5.9, post test mean = 11.4 from a possible 20 points). A 94.1 percent improvement was achieved in dictation-transcription weighted wpm (mean 14.9 to 28.9). Other outstanding gains were achieved in the areas of mathematical symbols (mean 13.7 to 20.1), total science score was (30.5 to 49.3) and earth science plus astronomy (mean 8.3 to 13.0). The smallest significant improvement occurred in mathematics problems (mean 9.06 to 10.35).

Only one of the four measures that did not show statistically significant improvement failed to register even a small gain. The dictation rate code pretest mean was 2.4 and post test code mean was 2.5 where a code of 1 = 110 wpm, 2 = 90 wpm, 3 = 70 wpm, and 4 = 00 wpm. The post test dictation rate was about two wpm slower than the pretest mean rate. The other three areas of non-significant in the statistical analysis did show positive gains and occurred in the evaluation of percentage errors for five minute straight copy (mean 2.3 to 1.6), five minute statistical copy typing (mean 2.3 to 1.7), and non-technical spelling (mean 90.97 to 91.24 percentile).

The pretest mean scores for the ten dropouts were inferior to those of the 34 successful trainees on all twenty pre and post measures and also on the five additional pretest measures. The three most spectacular differences between the dropout and successful trainee pretest mean scores occurred in the area of English mechanics of expression (47.3 to 169.6), percent of errors on five minute straight copy typing (12.2 to 2.2) and percent errors on five minute statistical copy typing (12.00 to 2.25). The three measures of English performance and the verbal intelligence score showed substantially lower pretest mean scores for the dropouts compared to the 34 trainees completing the training program.

TABLE III

SCIENTIFIC SECRETARY TRAINING PROGRAM TEST SCORE REPORT

Test	Possible Range	Pretest N = 10 Dropout Average	Pretest N = 34 Class Average	Post test N = 34 Class Average
Typing,5' straight copy				
Gross wpm	0-∞	57.4	62.41	74.18[s]
% Errors	0-∞	4.25	2.83	1.59
Typing, 10' rough draft				
Gross wpm	0-∞	27.5	33.85	40.38[s]
% Errors	0-∞	1.5	0.60	0.09[s]
Typing, 5' statis. copy				
Gross wpm	0-∞	49.0	55.65	67.03[s]
% Errors	0-∞	4.89	2.25	1.66
Dictation				
Rate Code[a]	1-4	2.9	2.41	2.50
Weighted wpm[b]	0-∞	9.8	14.86	28.85[s]
% Accuracy	0-100	60.3	79.29	94.97[s]
English				
Coop Expression*	*	47.3	169.59	172.82[s]
DAT Spelling**	0-99	81.0	90.97	91.24
DAT Sentences**	0 99	59.9	76.56	87.35[s]
Mathematics (no. right)				
Problems	0-15	8.5	9.06	10.35[s]
Symbols	0-33	12.5	13.18	20.03[s]
Science (no. right)				
Physics	0-33	7.8	8.29	11.82[s]
Chemistry	0-20	4.8	5.88	11.44[s]
Biology	0-6	3.0	3.82	5.15[s]

*Converted score based on a range of 115-191 (pretest) and 115-194 (post test).

**Percentile score = percentage of publisher's norm group receiving lower scores.

[a] 1 = 110 wpm, 2 = 90 wpm, 3 = 70 wpm, 4 = 00 wpm.

[b] Gross wpm. times dictation rate in wpm/100 = weighted wpm.

s = Statistically significant (.05 level) change in group score from pretest to post test.

Test	Possible Range	Pretest N = 10 Dropout Average	Pretest N = 34 Class Average	Post test N = 34 Class Average
Earth Sci. & Astron.	0-25	7.9	8.32	13.00^{s}
Computers & Math	0-16	4.5	5.15	7.85^{s}
Total score	0-100	28.0	30.50	49.26^{s}
Minnesota Clerical (no. right)				
Number comparison	0-200	130.1	140.29	-
Name comparison	0-200	139.3	158.68	-
Wechsler Adult Intell. Scale		N = 5		
Total verbal***	0-100	68	86.15	-
Total performance***	0-100	75	75.21	-
Grand total***	0-100	78	83.47	-

Teachers' evaluation of trainees' progress.

At the end of the pilot training program each instructor rated each trainee on a three point scale as belonging to the top, middle, or bottom third of the class. A composite of these individual class ratings was used to assign a final performance rating to each trainee who completed the program. All trainees who dropped out of the program received the same rating even though some were quite capable and performed well at the time they withdrew. The final rating of all 46 trainees who began the project showed 11 (top), 16 (middle), 7 (bottom), and 12 (drop-out). Very few of the trainees changed from their midterm (December, 1966) and final (June, 1967) rating. Also, those assigned to the A and B skill groups generally remained where they were placed by the pretest data.

The achievement of the trainees reported in the pre and post test study indicated that good progress was made by the group as a whole. However, the seven trainees given a lower third (3) final rating attained a level of achievement which seems questionable in terms of satisfactory performance as a scientific secretary. The twenty-seven with top or middle third ratings appeared not only to have gained considerably from the pilot training program, but also, to have attained a final level of achievement adequate for satisfactory to good performance as a scientific secretary. (See Appendix H for final composite rating of trainees).

Evaluation of curriculum objectives.

The nineteen objectives of the training program were evaluated two times by the trainees (June, 1967, and Dec., 1967), once by the course instructors and Committee (June, 1967), and once by the trainees' supervisors (Marhc, 1967). The rating form appears in Appendix I and provides a statement of each of the curriculum objectives.

The results of the evaluation of curriculum objectives are reported in Table IV below.

TABLE IV

MEAN RATINGS OF CURRICULUM OBJECTIVES

Curriculum Objectives*	Trainees June, 1967	Trainees Dec., 1967	Instructors	Committee of SSTP	Supervisors of Trainees	Total MEAN
A. SKILLS						
1	5.24	5.23	6	6	5.40	5.64
2	6.03	5.55	5.5	6	5.83	5.73
3	4.18	4.48	5	4	5.22	4.58
4	3.85	4.23	4	4	4.67	4.15
5	3.97	4.13	4	4	5.67	4.35
6	4.38	4.58	4.5	5	5.31	4.69
7	5.71	5.91	6.5	6	5.70	6.05
Average	4.77	4.87	5.07	5.00	5.40	5.03
B. SCIENCE						
1	5.88	5.56	6	6	5.55	5.80
2	5.41	5.53	6	5	5.71	5.53
3	5.79	5.41	6	5	5.33	5.51
4	5.27	5.28	7	5	4.75	5.46
5	5.38	5.41	7	6	5.00	5.76
Average	5.55	5.44	6.70	5.40	5.27	5.61
C. ENGLISH						
1	5.21	5.19	4	-	5.83	5.06
2	4.77	5.00	4	-	5.70	4.87
3	3.91	4.28	5	-	5.36	4.64
4	5.62	5.12	5	-	5.92	5.42
5	5.62	4.97	4	-	5.67	5.06
Average	5.03	4.91	4.40	-	5.70	5.01
D. MATH.						
1	5.00	4.50	5	2	4.50	4.20
2	5.38	5.22	4	3	5.78	4.68
Average	5.19	4.86	4.50	2.50	5.14	4.44
Total Mean	5.08	5.03	5.26	4.79	5.42	5.12

*See Appendix I for statement of each curriculum objective.

The trainees rated the science curriculum objectives highest (mean of 5.6 and 5.4 on a 7 point scale), the mathematics objectives second highest (mean of 5.2 and 4.9 on a 7 point scale), the English objectives third highest (mean of 5.0 and 4.9), and secretarial skills objectives lowest (mean of 4.8 and 4.9). The rating of secretarial skills objectives was the only area where the mean ratings improved between the final June evaluation and the follow-up evaluation in December. In general, there was a high degree of consistency between the June and December total mean ratings of the four courses.

The trainees' mean rating increased (5.1 to 5.0) from July to December for the curriculum objectives related to skill in preparing technical documents for the printer (+ .38), the ability to compose letters (+ .37), and the writing of technical reports and proposals (+ .30). They decreased their mean rating in December for the attainment of the curriculum objectives related to appreciation for advanced mathematical methods and language (- .50), the ability to recognize and correct errors in grammar, word usage and syntax (- .50 and - .35), proficiency in taking and transcribing technical dictation (- .48), and a general qualitative understanding of those basic principles and processes of the natural and physical science (- .38). All of the below average and average mean ratings in June were raised in December while five of the six highest June ratings were lower in December.

The instructors' ratings were seldom more than one point above or below the trainees' mean ratings. The science curriculum objectives were rated quite high by the instructors as were the clerical skills objectives. Both the English and mathematics instructors rated the curriculum objectives lower than the trainees. The overall instructor mean rating was somewhat higher than the trainee mean rating.

The Committees' mean ratings for curriculum objectives were the lowest of all rating groups. The mathematics objectives mean rating was extremely low (2.5).

The mean ratings of curriculum objectives made by the supervisors of the trainees in March, 1967, were the highest of all group ratings (5.5). They felt most satisfied with the English objectives (5.7) and least satisfied with the trainees' attainment of the mathematics objectives (5.1). However, all curriculum objectives were rated well above average by the supervisors.

The results indicated that the two curriculum objectives receiving the lowest composite mean rating were A4--Development of skill in preparing technical documents for the printer and D1--Development of insight into and appreciation for advanced mathematical methods and language. The highest composite mean rating was given to A7--Development of an understanding of the need for accuracy, flexibility, tact, and patience in scientific secretarial work.

Trainees' evaluation of the pilot training project.

A tabulation of the responses obtained from the three program evaluation forms completed by the trainees (December, 1966, June, 1967, and December, 1967) is presented in Table V. The responses of the dropouts from the program also were tabulated and are presented in Appendix J. A further tabulation of the trainees' most frequent comments concerning unsatisfactory (U) ratings is presented in Appendix K.

TABLE V

MIDTERM, FINAL AND FOLLOW-UP EVALUATION OF THE SSTP BY THE TRAINEES WHO COMPLETED THE PROGRAM

Evaluation Question No. (Appendix E)	Rating**	Frequency of Ratings on Evaluation Questionnaire															
		Skills			Science			Math			English			Totals			Grand Total
		1*	2*	3*	1*	2*	3*	1*	2*	3*	1*	2*	3*	1*	2*	3*	
IA	E	33	27	25	19	16	21	13	8	7	21	12	3	86	63	56	205
	S	1	7	7	13	18	11	17	21	19	12	19	17	43	65	54	162
	U	0	0	0	2	0	0	4	5	6	1	3	12	7	8	18	33
IB	E	9	8	8	5	8	5	5	5	1	5	3	0	23	24	14	61
	S	22	24	22	24	23	25	19	20	20	29	29	30	94	96	97	287
	U	3	2	2	5	3	2	10	9	11	0	2	2	18	16	17	51
IC	E	10	9	4	2	1	2	0	0	0	5	4	5	17	14	11	42
	S	19	20	23	10	18	17	13	15	16	26	28	26	68	81	82	231
	U	5	5	5	22	15	13	21	19	16	3	2	1	51	41	35	127
IIA	E	31	33	26	16	20	15	8	7	3	24	24	15	79	84	59	222
	S	3	1	6	14	11	17	16	20	17	10	10	16	43	42	56	141
	U	0	0	0	3	3	0	9	7	12	0	0	1	12	10	13	35
IIB	E	28	25	25	18	19	19	10	14	9	14	11	9	70	69	62	201
	S	5	9	7	14	15	13	18	16	15	15	20	19	52	60	54	166
	U	1	0	0	2	0	0	6	4	8	1	3	4	10	7	12	29

* 1 = 1st Evaluation 12/66 (N = 34); 2 = 2nd Evaluation 6/67 (N = 34)
3 = 3rd Evaluation 6 mo. follow-up (N = 32)
** E = Excellent S = Satisfactory U = Unsatisfactory

Evaluation Question No. (Appendix E)	Rating**	Frequency of Ratings on Evaluation Questionnaire																
		Skills			Science			Math			English			Totals			Grand
		1*	2*	3*	1*	2*	3*	1*	2*	3*	1*	2*	3*	1*	2*	3*	Total
IIC	E	29	25	22	14	12	12	7	4	4	18	14	7	68	55	45	168
	S	5	9	9	15	19	19	17	19	17	15	16	21	52	63	66	181
	U	0	0	1	4	3	1	9	11	11	1	4	4	14	18	17	49
IID	E	29	29	25	20	21	18	17	14	11	16	16	13	82	80	67	229
	S	4	5	7	11	11	13	12	14	15	18	17	17	45	47	52	144
	U	0	0	0	3	2	1	4	6	5	0	1	1	7	9	7	23
IIE	E	22	20	10	15	12	10	7	3	1	12	13	7	56	48	28	132
	S	10	9	18	16	13	16	14	8	12	17	12	20	57	42	66	165
	U	2	5	4	3	9	6	12	23	19	5	9	5	22	46	34	102
IIF	E	28	29	21	22	26	29	18	19	13	23	13	10	91	87	73	251
	S	6	5	11	11	8	3	14	10	14	10	19	17	41	42	45	128
	U	0	0	0	1	0	0	2	5	5	1	2	5	4	7	10	21
IIG	E	15	15	11	13	10	6	14	7	4	18	12	6	60	44	27	131
	S	15	17	19	12	17	21	14	21	21	14	21	21	55	76	82	213
	U	4	2	1	9	7	4	6	6	6	2	1	4	21	16	15	52
IIH	E	19	18	10	17	12	9	15	12	5	20	13	9	71	55	33	159
	S	15	16	21	11	21	21	15	18	23	13	21	21	54	76	86	216
	U	0	0	1	6	1	2	4	4	4	1	0	2	11	5	9	25
II-I	E	18	17	10	14	14	7	14	15	7	16	15	8	62	61	32	155
	S	16	17	22	19	20	23	18	18	22	18	18	24	71	73	91	235
	U	0	0	0	1	0	2	2	1	2	0	1	0	3	2	4	9
Total[1]	E	284	255	197	175	171	153	128	108	65	192	150	92	765	685	507	1,956
	U	15	14	14	61	43	31	89	100	105	15	28	41	180	185	191	536

[1] the total frequency for the third evaluation is based on two less trainees and thus there are 24 less ratings available in the total E, S and U scores.

Each trainee rated the twelve questions for the four curriculum areas as excellent, satisfactory, or unsatisfactory. The rank order of their composite excellent ratings showed the following: IIF--Is the class interesting and/or stimulating?(251), IID--Is the content relevant to the work of a scientific secretary, as you understand the job? (229), IIA--Is the instruction presented at an understandable level? (222), and IA--In terms of your conception of a scientific secretary's work, please rate the relevance of the four areas of instruction (205). The rank order of their composite unsatisfactory ratings were as follows: IC--Rate the degree to which your previously acquired skills or knowledge prepared you for work in each area (127), IIE--Has enough time been scheduled for each area? (102), IIG--Is the amount and difficulty of in-class work reasonable? (52), IB--How would you rate your own degree of improvement in the knowledge and skills covered by each area? (51), and IIC--Does the method of instruction seem effective for efficient learning of the content? (49). The largest satisfactory rating was given to IB--(287) and the smallest satisfactory rating was given to IIF--(128).

In December, 1966, almost everyone (30 or 34 or 88.8%) marked one or more U's (unsatisfactory) to question IC--Rate the degree to which your previously acquired skills or knowledge prepared you for work in each area. Over one-third (37.5%) of the total responses to the four subject areas for IC were U while only one-eighth (12.5%) were E (excellent). The situation changed somewhat by June, 1967, so that the greatest number of U's were given to question IIE--Has enough time been scheduled for each area? (33.8%). Both IC and IIE received the largest number (27%) of U's in the follow-up evaluation (December, 1967).

Mathematics and science represented the major concern of the trainees in regard to weak background (IC). About half (47%) indicated a weakness in both mathematics and science, while another third (32.4%) indicated a weakness in either mathematics or science and only one-fifth (20.6%) felt their background was satisfactory. Only two people (3%) indicated an excellent background in science, and no one claimed an excellent mathematics background.

Since all of the remaining questions were directly related to the instructional program rather than the background of the trainees, they have been summarized and are presented as one unit.

Six trainees (17.6%) in December, 1966, did not mark any items with U. Six other trainees (or 17.6%) marked 72 of the 129 U's (or 56%). Thus about one-sixth of the trainees marked over half of the U's. One person alone marked 19 U's (or 14.7%) while 22 (or 64.7%) of the trainees marked only 57 (or 44%) of the U's.

The unsatisfactory ratings related to the four instructional areas are summarized and presented in Table VI.

TABLE VI

TRAINEE EVALUATION OF INSTRUCTIONAL AREAS

Course	Number of Unsatisfactory Ratings Midterm	Final	Follow-up*
Mathematics	68	81	89
Science	39	28	18
English	12	26	40
Skills	10	9	9
Total	129	144	156

*Two less trainees rated the program.

At the midterm evaluation there were 107 U's given to mathematics and science. Forty-two (or 39.2%) of the total U's were marked as pairs in both mathematics and science by twelve (35.2%) of the trainees. One person alone marked five pairs of U's in mathematics and science.

The five questions that received 50% or more excellent (E) ratings were: IIF--Is the class interesting and/or stimulating? (62.8%); IID--Is the content relevant to the work of a scientific secretary as you understand the job? (57.9%); IIA--Is the instruction presented at an understandable level? (55.8%); IA--In terms of your conception of a scientific secretary's work, rate the relevance of the four areas (51.2%); and IIB--Are the instructional materials appropriate for the students in the course? (50.8%). English and mathematics lost the largest percentage of the midterm excellent ratings in the final and follow-up evaluations.

Supervisors' evaluation of trainees' on-the-job performance.

In March and again in December of 1967, six months after the completion of the pilot training program, the work supervisors of the trainees were asked to evaluate their on-the-job performance. In December, 1967, the evaluation form (Appendix F) was used as an interview instrument with the supervisors of the thirteen trainees who were then employed as secretaries in a scientific setting and was mailed to the remaining supervisors. Because of personnel changes within the employing organizations and job changes effected by the trainees after completion of the training program, there was not a continuity of the same supervisor-trainee relationship in a number of instances. Consequently, the supervisors could not always use the time period of March to December as their frame of reference in responding to the evaluation form.

There was only one reported instance of an employing organization changing a secretarial job title to include designation of a technical or scientific specialty. Two trainees were employed as technical typists. Several trainees had job titles that suggested a high level of responsibility; such as executive secretary, private secretary, office supervisor and supervisory purchasing agent.

In nine instances, the supervisors reported that the trainees had been given promotions or had been hired in new jobs as a result of the specialized training they had received. Three other trainees were reported to have the potential for promotion in the future. Some examples of the supervisors comments were:

> "One of the reasons we hired (name omitted) was because she had taken your course and done so well in it. She submitted samples of her technical skills with her application. Two of our top scientists have given her technical reports to type and have lauded her ability to us."
>
> "Her change from Secretary I to that of Technical Typist I resulted in an upgrading of one pay grade and was due to the Scientific Secretary Training Program."
>
> "(name omitted) was promoted to confidential secretary while in the program. The training was one factor considered in the promotion."
>
> "The Scientific Secretary Training Program improved her value. She shows more dedication to her work."
>
> "The Scientific Secretary Training Program qualified (name omitted) to be hired in September, 1967, and led to her selection over other applicants."
>
> "(Name omitted) would have been hired as a clerk instead of a stenographer if not for the Scientific Secretary Training Program."
>
> "She has received a promotion to the top job in her office with an estimated salary of $700.00 per month."
>
> "She has received both a promotion and merit increase due to the Scientific Secretary Training Program."

Nine supervisors reported that the trainees had been given new responsibilities or assignments other than promotions. In each instance the trainee's new responsibilities and assignments were reported as being more specialized in the scientific organization, ranging from technical typing and technical shorthand-transcription to library research and compiling research reports.

Ten supervisors reported that the trainees had received salary increases or other benefits but that it was not possible to attribute these benefits solely to the training program.

The most frequently reported changes in the trainees' performance were improved interest, attitude, and overall job performance. Improvement in speed and accuracy in typing and shorthand were the most frequently reported changes in secretarial skills. Increased understanding of terminology was the most frequent change reported with respect to the trainees' knowledge of science. Increased awareness of correct word usage was the most frequently reported change in knowledge of English. The most frequently reported instances of no change occurring in the trainees' performance was with respect to knowledge of mathematics.

The supervisors' recommendations and suggestions for improving the training program included the following:

Need more emphasis on correct word usage, grammar.

Study of symbols and terminology is sufficient for mathematics.

Mathematical problems need not be stressed.

Technical shorthand should be emphasized.

Separate technical typing from full scientific secretary curriculum to speed up skills training.

It would be helpful to include sessions on reading electronic schematics, wiring devices, lists of materials.

Good secretarial skills background should be a prerequisite.

Trainees should have a bachelor's degree with a major in science and then train in secretarial skills.

Should have a broader course framework including courses in social institutions, general humanities, and advanced English composition.

Should have an expanded program to include more hours of instruction.

A university can handle this type of training better, and with less expense, than can a company.

Among other interesting, voluntary comments offered by the supervisors were the following:

> An SSTP trainee has the edge in job getting and improving on the job.
>
> Understanding scientific notation and something of the logic of scientific thought helps in communicating with other workers.
>
> The SSTP trainee is much more advanced as a secretary.
>
> Better to take training after the trainee is placed within a scientific setting.
>
> The most significant contribution of the SSTP is its motivation. It encourages secretaries to take more courses.
>
> Scientific secretaries need more experience and maturity than other secretaries.
>
> It would be wonderful to have such a course offered in our area (Illinois).

Characteristics of the Trainees

Trainee biographical data.

The following tabulations give a distribution breakdown on the thirty-four trainees who completed the training program and the ten dropouts with regard to their residence, approximate ages, previous work experience, present employment, and levels of education. The two trainees who dropped out after the first meeting are not included in these tallies.

Residence

City	Total Trainees	Dropouts
Boulder	20	6
Denver	10	
Denver vicinity	8	1
Longmont	2	
Golden	2	1
Louisville	1	1
Eldorado Springs	1	1
Total	44	10

Approximate Age

Age Group	Total Trainees	Dropouts
18-19	2	
21-25	5	3
26-30	7	2
31-35	3	3
36-40	2	
41-45	17	4
46-50	4	
51-54	4	
Total	44	10

Previous Work Experience

Type of Work	Total Trainees	Dropouts
Secretarial or clerical	32	9
Scientific secretarial	10	1
Other (medical technician, keypunch, teacher, nurse)	7	5
	49*	15

Present Employment

Type of Job	Total Trainees	Dropouts
Secretarial (scientific)	16	
Secretarial (non-scientific)	20	7
Nursing	1	
Unemployed	7	3
Total	44	10

Level of Education

Educational Level	Total Trainees	Dropouts
High School only	9	1
Secretarial and/or Business School	13	1
Other post-high school	5	1
Some college	21	3
College graduate	5	7
Total	53**	12**

---

*Some trainees had more than one type of previous work experience.

**Some trainees had completed more than one level of post-high school education.

Trainee Test Data.

The data from three typing tests and one dictation test were used in assigning trainees to subgroups A (faster) and B (slower) for instructional purposes. It was apparent that the trainees had a fairly wide range of secretarial skills as well as English, mathematical and science proficiency. This was to be expected and was in keeping with the research design. An indication of the trainees' apparent weakness in science and mathematics can be readily observed from the mean scores reported in Appendix L. The trainees' secretarial skills, though relatively better than their mathematics and science achievement, were still somewhat limited. The trainees who were assigned to the slower group might even be classified as borderline in terms of marketable secretarial skills.

Both the pretest and WAIS data would indicate that the trainees were capable of learning an adequate amount of information in the areas of mathematics and science as well as improving their secretarial skills. Although some trainees consistently scored low on this battery of tests, it did not appear that there were any who were incapable of profiting from the pilot training program. It is possible that a few trainees had such high capabilities that they found the program insufficiently challenging.

A summary of the test data for the dropouts is presented in Appendix M. Four of the dropouts were classified into the A subgroup on the basis of good secretarial skills. All four of the A subgroup dropouts and two of the six B subgroup dropouts were above average on a majority of the pretest scores. At least half of the dropouts were quite capable individuals. The other four of the B subgroup dropouts placed above the mean only on one to four of the twenty pretest scores. They were definitely more limited than the 34 successful trainees in both background preparation and ability, but probably could have benefitted from the training program.

About half of the dropouts represented high risk or borderline trainees. The other half of the dropouts scored above average on a majority of the pretests and would likely have completed the course quite satisfactorily if personal problems or other demands on their time had allowed them to remain in the program. The type of person who dropped out was about equally represented in the high risk and low risk categories so that the important characteristics of the trainees who completed the pilot program remained relatively unchanged by the loss of about one-fourth of the trainees originally selected.

Some trainees were as low as fifth grade or perhaps junior high school level in regard to mathematics and science knowledge. They had above-average general intelligence and would compare fairly well with a freshman college class in ability, but they were far below an average college freshman class in content and achievement related to mathematics and science. They were far above an average college freshman class in secretarial skills. In general, the trainees were mature, intelligent, adult women who specialized in secretarial functions, but were very weak and undeveloped in the areas of science and mathematics.

At the completion of the pilot training program, each instructor rated each trainee on a three point scale as belonging to the top (1), middle (2), or bottom (3) third of the class. A composite of these individual class ratings was used to assign a final performance rating to each trainee. All trainees who dropped out of the program received a rating of four (4) even though some were quite capable and performed well. All 46 trainees who were originally accepted in the program were divided into the above four groups and compared. There were 11 one's, 16 two's, 7 three's, and 12 four's.

The four rating groups above were compared by use of an analysis of variance design to determine which of 52 variables would be useful to describe the final rating groups.

Significant differences were found between group mean scores on several variables. The most useful variables have been ranked according to their analysis of variance F value and are reported in Table VII. This table reports the mean scores for the most important variables. The data support the results of the regression analysis study and show the usefulness of the DAT Spelling test as an indicator of success in the program. Both rating Groups 1 and 2 showed quite high spelling mean scores while both Groups 3 and 4 were similar but considerably lower than Groups 1 and 2. The Cooperative English Expression test scores and the Wechsler Vocabulary subscore show approximately the same tendency although not so precise.

Several mean score comparisons such as chemistry, Minnesota Clerical Name Comparison, 5 minute straight copy typing gwpm, and 10 minute rough draft typing gwpm appear to be quite useful to distinguish between the high and low rating groups.

TABLE VII

COMPARISON OF MEAN SCORES FOR FINAL RATING GROUPS

Variable Name	Rating Group Mean Scores M_1	M_2	M_3	M_4	F Value
DAT Spelling	96.2	94.6	85.6	83.6	6.468**
Coop. English Expression	68.8	59.1	53.0	48.7	5.289**
WAIS Vocabulary Subscore	69.4	63.2	54.1	59.0	4.500**
Science-Chemistry Subscore	7.2	5.8	4.0	4.8	4.226*
Minnesota Clerical Name Comparison	168.4	160.3	139.6	139.3	4.075*
5 min. Straight Copy gwpm.	65.4	64.8	52.3	58.0	3.881*
Dictation Rate wpm.	18.0	20.0	7.7	12.3	3.837*
Science Total Score	35.3	29.7	24.9	28.0	3.684*
10 min. Rough Draft gwpm.	37.2	34.4	27.4	29.2	3.551*
WAIS Verbal IQ	124.3	117.1	115.9	111.2	3.549*
WAIS Information Subscore	21.6	20.2	18.0	18.4	3.263*
5 min. Statistical Copy gwpm.	58.3	57.2	47.9	49.9	3.239*
Dictation Accuracy (%)	86.0	87.9	49.1	66.1	3.122*
Shorthand Speed on Application gwpm.	101.7	94.1	81.7	82.5	2.923*

* $p > .05$ level of significance
** $p > .01$ level of significance

Variable Name	Rating Group Mean Scores M_1	M_2	M_3	M_4	F Value
WAIS Total IQ	120.6	115.1	115.4	110.2	2.662
Mathematics Symbols	15.1	12.6	11.6	12.5	1.686
5 min. Statistical Copy Errors	5.2	8.2	6.4	11.2	1.687
Age	37.1	40.9	40.6	32.4	2.008
No. of Years Previous Employment	5.9	7.2	7.3	3.8	1.565
DAT Sentences	67.3	61.6	56.0	61.0	1.031

The research design required applicants to have at least minimal qualifications. There was also a concern for including some people who represented the extremes of experience, age, skills, ability, and personality. Although a fairly wide cross section of some characteristics was secured it was also apparent that the group was fairly homogeneous in regard to such factors as sex, secretarial experience, interest in the field, and future objectives.

The results of test data and observations were carefully screened for evidence leading to further description of the nature of the trainee group and especially in an attempt to discover which characteristics, if any, could be used to predict success in the training program. A major problem was that no one was admitted who couldn't succeed, and no one who completed the course failed so that success was strictly a matter of degree and not a clear-cut criterion.

The characteristics given serious consideration were: introversion-extroversion; flexibility-rigidity; social adaptability-unadaptability; energy level; ability level; general drive or motivation to succeed and degree of compulsivity. The trainees were divided into three groups for this phase of the study: top third, bottom third, and dropouts (with complete data).

The first three of these personality characteristics or dimensions were fairly well distributed across all three groups listed above and only the degree of each characteristic could be identified as possibly related to performance in the training program. The trainees who had the highest achievement tended to be introverts who, through compensation, had adopted an extroverted pattern of behavior. They were fairly flexible although about half of them became flexible by compensation of a fairly rigid childhood background. They were predominantly unadaptable (as opposed to adaptable) in their social role. As a group the trainees were relatively mature and successful secretaries. They were somewhat insecure as people and needed considerable structure, supervision, and encouragement. They were relatively good in clerical skills but quite limited and insecure, although interested in mathematics and science.

The top third of the trainees consisted of a moderately homogeneous group characterized by good to excellent verbal ability for all but two individuals who had only average ability. All but one of the top group had good energy; all but four were generally well motivated; and no one had either too much or too little obsessive-compulsive tendency.

The bottom third of the trainees, who incidentally completed the course successfully and actually made good progress on the pre and post test battery, can be characterized as also having good to excellent ability (only two had average ability on national norms); all but three had good energy; all but four were generally well motivated; and seven of eleven were well adjusted in regard to obsessive-compulsive tendencies. There was only a slight difference in the personality of the top and bottom third of the trainees, and this is not too surprising since both groups completed the program satisfactorily. The key to understanding the influence of personality factors here is the balance of the four areas of ability energy, motivation, and compulsiveness. In the top group, there was never more than one weak area while four trainees had no weak areas. The bottom third contained only four trainees with one weak area, six with two weak areas, and one with three weak areas. Two of the five dropouts with complete data showed that the two who were the last to withdraw had only one weak area; two other dropouts had two weak areas, and one had three weak areas. Thus it appears that the trainees who were rated highest were either well equipped on all four dimensions of personality or able to compensate for their one relatively weak dimension. The bottom third of the trainees had slightly less to work with and several of them were forced to compensate on two or three personality dimensions. This was in addition to possible handicaps in content background, time and energy left over from full-time jobs and home responsibilities. The true value or total impact of these personality characteristics can be understood best in relationship to the pretest data, home and work responsibilities and various other factors related to the training program.

The Prediction of Success in the Scientific Secretary Training Program

The results of the multiple regression analysis indicated that (subject to cross-validation) the final rating of the participants in the pilot training program can be predicted with considerable accuracy. The multiple correlation of pretest data with final performance ratings based on a composite of top, middle, and bottom third ratings (as well as dropout) in the four subject areas was .86 (Table VIII).

TABLE VIII

MULTIPLE CORRELATION AND REGRESSION EQUATION FOR FINAL TRAINEE RATING

R	Variable Name	Sign and Beta Weight
.609	DAT Spelling	+.04588
.687	WAIS Verbal IQ	+.04911
.786	DAT Sentences	-.05485
.819	Coop. Expression	+.03312
.845	Shorthand Speed on Application	+.01366
.861	Science-Chemistry	+.08890
	(Constant)	+12.53326

The correlations with persistency in the project were also quite high (Table IX).

TABLE IX

MULTIPLE CORRELATION AND REGRESSION EQUATION FOR NUMBER OF MONTHS TRAINEES REMAINED IN TRAINING PROGRAM

R	Variable Name	Sign and Beta Weight
.579	DAT Spelling	-.13566
.657	WAIS P. Completion Perspective*	+.42802
.690	DAT Sentence	+.14095
.782	WAIS Verbal IQ	-.16996
.807	WAIS Picture Completion	+.27547
.825	Coop. Expression	-.06862
	(Constant)	+13.44591

*1 + 2 ($PC_5 + PC_{10} - PC_{11} - PC_{14} - PC_{15}$)

The six variable multiple correlation (R) with final performance rating (1 = top, 2 = middle, 3 = bottom, 4 = dropout) was .86 with a standard error of estimate (S.E.) of .60.

The best single predictor of final standing was the Differential Aptitude Test (DAT) Spelling test with a pearson product moment correlation (r) of .61 and a standard error of estimate of .88. The next best variable for multiple regression prediction of final performance rating was the Wechsler Adult Intelligence Scale (WAIS)

Verbal IQ with a pearson r of .51, a multiple correlation (R) of .69 and an S.E. of .82. The next four most useful pretest variables in the regression equation were as follows: DAT Sentences, Cooperative English Expression Test, the trainee application statement of shorthand speed and the chemistry subtest score based on twenty questions of the 100-question science pretest.

Other promising variables that correlated well with the final performance rating but did not account for substantailly more variance in the multiple prediction equation were: Wechsler Information subscore (r = .48), 10-minute rough draft gross words per minute (gwpm) (r = .47), Minnesota Clerical Name Comparison (r = .46), Wechsler Total IQ (r = .46), Wechsler Vocabulary subscore (r = .45), pretest five-minute statistical copy typing gwpm (r = .41), pretest shorthand dictation rate (r = .39), pretest science total score (r = .37), pretest five-minute straight copy typing gwpm (r = .37), and pretest shorthand percentage accuracy (r = .36). (See Appendix N for the r of the remaining variables).

The prediction of final rating and length of time a trainee will remain in the training program utilized basically the same variables, especially the DAT English Spelling test. (See Table IX and Appendix O).

The prediction of improvement in secretarial skills, mathematics and science also relied most heavily upon the DAT Spelling test score whereas the prediction of improvement in English was dependent primarily upon the Coop Expression test score. (See Appendices P, Q, R, S). Age and shorthand speed reported on the trainee application blank were positively related to improvement in both secretarial skills and English. The number of years of previous employment was positively related to improvement in both mathematics and science. However, the teachers' ratings received by the trainees with respect to the top, middle, and bottom third on composite achievement in all areas showed little, if any, relationship to prior work experience as a secretary in a scientific setting.

IV

DISCUSSION

The Questionnaire and Interview Results

An analysis of the questionnaire and interview results (Appendix G) showed the secretaries themselves primarily as secretaries and not as assistant scientists. Their supervisors, however, would like them to be able to take over several additional tasks. The supervisors and personnel managers rated secretarial skills as the most important, but they mentioned frequently the need for technical training such as technical terminology, knowledge of science, scientific terminology, basic science, plotting data, scanning technical publications for significant material and data reproduction. The supervisors were fairly well satisfied with the present level of secretarial skills, but they were quite definite in their desire for secretaries with more scientific and technical training.

The data in Tables I and II (pages 21,22) suggest that there was strong support for a training program that included basic secretarial skills with a technical emphasis, science and technical terms, English, mathematics of some type, and science of some type. Also mentioned, but to a lesser degree, were courses like foreign language, business understanding, business or office administration, physics, data processing, public relations, and use of computers and automatic office equipment. There seemed to be a lack of definitive agreement concerning just what type of mathematics and science courses were needed. No indication was found that the secretaries should be trained as junior scientists. The scientist's need for help was described more in terms of giving the secretaries increased self-confidence, basic scientific orientation and appreciation of the work of a scientist so that they could take over more responsibility in the scientific setting.

With the anticipation of coming automation and computer programming in office procedures, it was somewhat surprising that very few recommended an appropriate training course for computers and automated office equipment.

In general, the results of the interviews and the questionnaires indicated strong support for a curriculum that emphasized basic secretarial skills, English, mathematics, and basic science with an emphasis on technical terminology. Other concerns expressed were for business and public relations training. Accuracy, poise, and getting along with people also were reported as important traits needed by scientific secretaries.

Description of the Pilot Training Program

A complete description of the course content and instructional methods and materials used in the pilot training program is contained in the curriculum guides in Appendices _T_ _U_ _V_ and _W_. Only a brief summary of the nature of the pilot training program is presented here in order to provide an overview of the instructional program.

The results of an analysis of the questionnaire and interview data showed that all three sample troups felt that a training program for scientific secretaries should include not only secretarial skills and introductory general science, but instruction in English and mathematics as well. Curriculum objectives based on the results of the analysis were subsequently drawn up by the project staff members responsible for curriculum development in each of these four areas and may be summarized as follows:

1. Secretarial Skills.

    a. developing skill in technical typing, using preferred styles for typing equations, formulas, abbreviations and symbols.

    b. developing proficiency in taking and transcribing technical dictation.

    c. developing concepts about writing technical reports and proposals and skill in preparing such documents for the printer.

    d. developing skill in using, classifying, and filing scientific material.

    e. developing knowledge and understanding of the different phases of a scientific secretary's job, including principles of office management and administration; planning; scheduling and organizing procedures.

    f. developing an understanding of the need for accuracy, flexibility, tact, and patience in scientific secretarial work.

    g. reinforcing the learning in science and mathematics by coordinating the materials used for typing and shorthand.

2. Science.

   a. to provide the trainees with a basic knowledge of terminology in a wide range of scientific fields.

   b. to develop an understanding of the frame of reference of the scientist, and the procedures, equipment, and language involved in scientific research.

   c. to develop a general, qualitative understanding of those basic principles and processes of the natural and physical sciences which would enable the trainees to function effectively as secretaries in a variety of scientific settings.

   d. to develop skill in the use of library facilities and familiarization with pertinent scientific reference materials.

   e. to develop an understanding of the interrelations among scientific fields.

3. English.

   a. developing the ability to spell accurately.

   b. developing and increasing a knowledge of both technical and non-technical vocabulary.

   c. developing the ability to compose letters.

   d. developing the ability to recognize errors in grammar, word usage, and syntax.

   e. developing the ability to correct such errors and rewrite sentences and paragraphs more effectively.

4. Mathematics.

   a. to provide the trainees with some insight into and appreciation for advanced mathematical methods and language as these relate to scientific and technological research, including statistical analysis of data.

   b. to familiarize the trainees with the various mathematical symbols, expressions, and conventions used by scientists and engineers.

Upon reviewing the potential scope of the course content for the pilot training program, the Committee agreed that an estimate of approximately 320 clock hours of instruction represented a reasonable total time allotment for the training program. Consequently, a weekly schedule of ten class hours per week for a period of thirty-two weeks was adopted and a class schedule was prepared, allotting approximately four and one-half hour class periods a week to secretarial instruction, three and one-half hour periods to science, and one hour periods each to English and mathematics. Classes were scheduled for Tuesday and Thursday evenings and Saturday mornings in accordance with the prospective trainees' overwhelming perference for evening and Saturday sessions.

Due to the varying typing and shorthand skill levels of the trainees, it was decided that they would be divided into two groups in order to achieve a more homogeneous grouping in typing and shorthand proficiency. Trainees having better typing and shorthand skills were placed in Group A and the others were assigned to Group B. In order to facilitate class scheduling, the groups were scheduled separately in the science, English, and mathematics areas as well.

The program ran continuously from September 27, 1966, to June 3, 1967, with allowance made for the usual University holiday vacation periods. During the second semester some minor changes in scheduling were made on the basis of the midterm evaluation of the program by the trainees. The English and mathematics class schedules were altered temporarily so that trainees might have uninterrupted two-hour periods for their library work assignments. Slightly more class time was allowed for mathematics and, in the science and secretarial skills areas, there was a change of procedure so that more class time might be utilized for study and skills practice. Weekly class schedules for the first and second semesters are given below:

First Semester

Tuesday Evening

7:00 - 7:50	Group A - Mathematics; Group B - Secretarial Skills
8:00 - 8:50	Group A - English; Group B - Mathematics
9:00 - 9:50	Group A - Secretarial Skills; Group B - English

Thursday Evening

7:00 - 8:15	Group A - Science; Group B - Secretarial Skills
8:30 - 9:45	Group A - Secretarial Skills; Group B - Science

Saturday Morning

8:30 - 10:10	Group A - Science; Group B - Secretarial Skills
10:20 - 12:00	Group A - Secretarial Skills; Group B - Science

Second Semester

Tuesday Evening

7:00 - 8:00	Groups A and B meet together for special sessions--guest speakers, panel discussions, etc. This time was used for secretarial skills when no special sessions were scheduled.
8:05 - 9:00	Group A - Mathematics; Group B - English
9:05 -10:00	Group A - English; Group B - Mathematics

Thursday Evening

7:00 - 8:00	Group A and B meet together for science lectures.
8:10 - 8:55	Group A works on technical typing; Group B works on technical shorthand.
9:00 - 9:45	Group A works on technical shorthand; Group B works on technical typing.

Saturday Morning

8:30 -10:10	Group A - Secretarial Skills; Group B - Science
10:20 -12:00	Group A - Science; Group B - Secretarial Skills

During the course of the pilot training program, a number of supplies, materials, University equipment and facilities were made available to the trainees. These included:

1. Two classrooms for lecture-discussion sections and one machines room housing typewriters and dictation equipment. In addition, an adjacent simulated office equipped with a desk, typewriters, file, and bookcase was set up for the trainees' use.
2. Texts and reference materials in the four areas of instruction covered in the program.
3. Supplies, including three-ring binders, paper, typewriter erasers, rulers, and shorthand practice notebooks.

4. Thirteen Selectric Typewriters with scientific symbols for use in class, plus one executive and one Model C typewriter with Typits for scientific symbols for practice use.

5. Thirty-five manual typewriters for certain kinds of practice.

6. Fifteen IBM dictation stations for use in practicing machine transcription and taking shorthand at different speeds.

7. Tape recorders, movie cameras, slide projectors, and other audiovisual equipment as needed.

8. Laboratory facilities for the purpose of demonstrating scientific principles and introducing scientific terminology. These facilities were made available at the University of Colorado and at the Fairview High School.

9. University of Colorado library facilities for practice in library research methods.

10. University of Colorado computer facilities, as well as those of other agencies within the community, for demonstration purposes.

Selection of the teaching assistants for the program's four areas of instruction was made according to qualifications established by the University of Colorado and the Extension Division for instructors of Continuing University Studies. Special attention also was given to their areas of specialization, and the four teaching assistants selected were well qualified in this regard.

At various times throughout the year, the trainees also heard a number of visiting lecturers who were drawn from the University of Colorado faculty and from various scientific and industrial organizations in the community.

The following is a brief summary of the major emphases in each of the four areas of instruction and the instructional materials and methods used:

1. Secretarial skills and office administration.

Major emphasis in this area was placed on technical typing practice, including typing of scientific reports, and dictation practice in the fields of synthetics, life sciences, aerospace, physics, mathematics, electronics, electrical engineering, and communications. During the second semester, the area of administrative services was added to the secretarial skills curriculum and was carried concurrently with skill improvement. Topics studied in this area included public relations, information handling and records management, supervision and coordination, systems analysis and special secretarial duties such as scheduling procedures.

Instructional materials and methods included:

a. the use of special tools for technical typing, such as interchangeable keys, Typits, IBM elements, transfer sheets, and templates;

b. practice in taking dictation from technical and scientific materials at different speeds;

c. practice in using shorthand forms for technical words;

d. exercises in actual office practices;

e. visits to libraries and data processing centers;

f. visiting lecturers from scientific organizations who were brought in for special phases such as technical report writing; and,

g. reinforcing the understanding of introductory general science and technology by emphasizing technical word meanings and carefully selecting instructional material in typing and shorthand to coordinate content with units of scientific instruction.

2. Science.

In their science classes the trainees studied the basic principles and terminology contained in various texts covering the general areas of atomic and nuclear structure, chemical and nuclear reactions, industrial chemical processes, geological processes, weather and climate, the fundamentals of solar and stellar astronomy, genetics and evolution, ecology, basic electronics, computers and computer processes.

Materials and methods included:

a. Six paperbound books serving as introductory material for lectures and discussions covering the range of fields mentioned above. In addition the trainees were provided with a reference handbook, a science dictionary, and a weekly science magazine.

b. Field trips to a variety of scientific laboratories for the purpose of demonstrating laboratory equipment and techniques and reinforcing understanding of laboratory and scientific terminology and methods. The trainees also were given practice in performing simple experiments themselves to help them gain a more concrete understanding of certain scientific principles.

c. practice in locating scientific materials in a library.

d. student participation and discussion in class.

e. visiting lecturers in several of the fields being studied who discussed current research in their areas from the layman's point of view.

f. utilization of appropriate slides, charts, maps, graphs, and films.

g. study guides and terminology lists, which were used in connection with reading assignments.

3. English.

Major emphasis was placed on recognition and correction of errors in sentence structure and grammar, developing skills in editing, rewriting, summarizing information, library research, and correct spelling and pronunciation.

Teaching materials and methods included:

a. five books which were used as references or as sources of material for class discussions guided by the instructor.

b. a compilation prepared by the instructor of English errors commonly found in newspapers, scientific journals, television programs, and currently popular books, which was used as a basis for class discussions and exercises. In addition, the trainees brought to class examples from their own work or examples found in print of sentences about which questions could be asked. The trainees practiced correcting or rewording these sentences. While practice drills in error-spotting became progressively more difficult over time, continual attention was paid to the fundamentals.

c. reviews of previously studied material which continued throughout the year in the form of oral and written quizzes and exercises.

d. writing assignments which required some assempling of research information.

4. Mathematics.

During the first semester, emphasis was placed on developing a good background in the fundamentals of algebra and developing an understanding of methods or solutions of linear equations, systems of equations and simultaneous methods of solution. Further topics studied included slope of a straight line and higher order equations. Developing an appreciation of the processes of trigonometry, analytic geometry, differential and integral calculus, and the development of differential equations were covered during the second semester. The trainees also were taught how to read mathematical tables and use of a slide rule. Time did not allow for a detailed study of statistics; however, the trainees were introduced to some of the more common statistical terms and their uses.

Materials and methods included:

a. information sheets and assigned exercises on various topics.

b. handwritten material to be transcribed and typed.

c. lectures and class discussions based on information sheets, exercises and typing material.

A continuing effort was made throughout the year to integrate the four areas of instruction as closely as possible. The secretarial skills class, for example, practiced typing mathematical equations supplied by the mathematics instructor and the trainees also worked extensively on a joint science and English library project. Similar effort was made to correlate the material being studied in the science and secretarial skills areas. In addition to integration of the four areas, continuing emphasis was also placed on the practical application of skills and understandings to problems encountered in scientific secretarial work.

The responses to the evaluation questionnaires obtained near the midpoint of the pilot program in December of 1966 were examined carefully and were used to make certain modifications in the second half of the program. The most important modification was in regard to changing the level of classroom instruction in mathematics and science, which, at times, was found to have been above the level of comprehension of many of the trainees. More structured assignments and class discussions were provided, based on specific study questions. A slight modification in the schedule also was made in order to permit twenty minutes additional time per week for the mathematics class when all students (Groups A and B) could meet together.

Evaluation of the Pilot Training Program

Test results.

The first phase of evaluating the pilot training program was to compare the results of tests administered at the beginning and end of the pilot project. Some tests contained parallel forms which were ideal for this type of research design. Several of the tests were developed by the instructors specifically for this project and as such were less well refined and did not have parallel forms. Most of the material used in the teacher constructed instruments has been used in previous learning situations so that a reasonable degree of confidence could be placed in the test results. The nine-month interval between the pretest and post test administrations was considered sufficient to allow for a retest on an identical instrument, especially since no content feedback was given to the trainees following the pretest. The trainees were unaware that the same tests would be repeated at the end of the program.

Only four of the twenty pretest measures failed to reach the .05 level of significance. The .05 level of significance was chosen because of the relatively small sample size (N = 34) and the t computed for related samples under the one-tailed assumption.

The evaluation of dictation rate contained some inherent difficulties. Each trainee was given dictation at three rates (Code 1 = 110 wpm., 2 = 90 wpm., 3 = 70 wpm., 4 = 00 wpm.). Then each trainee was granted the option of choosing which of the three sets of dictated material she would transcribe. Obviously, the slower the dictation rate chosen the better the chance for a higher transcription rate and a lower number of errors. Since the dictation speed, transcription gwpm and number of errors were interrelated, it was necessary to consider all three for a valid evaluation. The interrelation of dictation rate and transcription gross words per minute (gwpm) was handled by dividing the dictation wpm rate by 100 and multiplying this quotient times the transcription gwpm. The results of this formula was called weighted wpm and was viewed as a correction factor to penalize those trainees who chose to transcribe a slower dictation rate and to reward those who selected a faster rate. The transcribing and typing errors were all converted into a percent accuracy figure based on gwpm. Thus the weighted wpm and percent accuracy figure was considered to be comparable across pre and post test results regardless of the dictation rate selected.

The fact that the dictation rate chosen by the 34 trainees for the post test was two wpm less (a higher code number) than the rate chosen for the pretest does not indicate a loss of proficiency during the pilot project but rather that the trainees became more aware of the need for accuracy and found it necessary to decrease their dictation rate slightly in order to increase their transcription weighted wpm from a mean of 14.9 to 28.9 and their percent accuracy from 79.3 to 95.0. Since both the weighted wpm and the percent accuracy increases were highly significant and the final level of achievement was quite good, it appears reasonable to conclude that the slight decrease in dictation rate of about two wpm (code mean = 2.41 to 2.50) resulted from the choice of the trainees and was of no serious concern or consequence. The outstanding increases in transcription rate and percentage accuracy were curriculum objectives of the pilot project and both were achieved.

Each of the other three statistically non-significant areas of pre and post test results contain some factors worthy of comment. Two of the three statistically insignificant results involved measures of percentage of error based on five minute typing tests. In both situations the pretest percentage of typing errors (errors divided by wpm) was only 2.24 and 2.25 respectively and thus very little, if any, possibility remained for a significant decrease in percentage of error on the post test. Therefore, it was not too surprising that the post test percentage of error (1.59 and 1.66 respectively) was not significantly lower than the pretest percentage of error (2.24 and 2.25) even though the errors decreased by about one-third and one-fourth respectively. Since the percentage of errors and the gwpm are so closely interrelated, any evaluation of one necessarily involves a consideration of the other. The gwpm typing rate increased significantly from pre to post test for straight copy from 62.4 to 74.2 and for statistical copy from 55.6 to 67.0. Thus, the curriculum objectives for typing skill were definitely achieved as verified by a significant improvement in gwpm and a substantial although not significant reduction in the percentage of errors.

It should be noted that some individual trainee's post scores showed a very small gain in gwpm but a large decrease in the number and percentage of errors, while other trainees showed a large increase in gwpm and a small decrease or even an increase in errors. The percentage error procedure corrected the above problem, but only in terms of errors. Some other correction procedure is needed that will take into consideration simultaneously the direction and amount of change both in gwpm and errors. The other observation is that two error measures showed significant improvement from pre to post test. The first was a decrease of 0.60 to 0.09 in percent of errors on typing 10 minutes of rough draft. The mean gwpm increased from 33.8 to 40.4 while the mean percent errors dropped six-sevenths of the pretest mean to an extremely low 0.09 percent (errors per 100 gwpm). It also should be noted that there was an increase from 79.3 to 95.0 percent accuracy for the dictation-transcription error measures.

The lack of significant improvement in spelling (90.97 %ile to 91.24 %ile) was of considerable concern to the Committee. A careful analysis of the situation was made and is worthy of some comment.

It is clear that the pretest mean was unusually high with the spelling percentile being within nine points of the maximum score. Furthermore, although the change in the pre and post test mean was not statistically significant in spelling, it was positive. When extremely high or low scores are achieved on the pretest, it is common to find slightly less extreme scores on a retest due to the statistical phenomenon known as "regression to the mean of extreme scores." Since the dropout mean score on the pretest was 81.0 percentile for the spelling test, it appears that most of the "regression to the mean" was downward due to the large number of extremely high scores on the pretest by the 34 trainees completing the project.

It also is possible that a non-significant although slightly positive gain on the spelling post test could be interpreted as indicating that this variable was quite reliable and very difficult to change, especially in a group of experienced secretaries. This hypothesis is supported by the fact that the spelling test was by far the most consistant and best single predictor of improvement, persistency and general success in the training program.

The Committee also noted that several trainees complained about the increased difficulty of the post test form as compared to the pretest form of the DAT Spelling test. When the scores of the nineteen trainees in the 97 to 99th percentile on the DAT Spelling pretest form A were compared to the alternate form B post test, twelve decreased and only seven stayed the same or increased. This point is quite important when it is noted that it involved over half of the trainees who had only from two to zero percentile points available for improvement. In addition to the lack of adequate test ceiling, the concept of "regression to the mean" appears to be operating here especially since the top trainees, with very few exceptions, improved their scores on all other pre and post tests.

Finally, it should be noted that the objective of the training was to improve technical or scientific vocabulary, spelling, shorthand, and typing. The Differential Aptitude Test instruments were not designed specifically to measure performance of a technical nature. The decision to use a standardized and published test with alternate forms and national norms which did not cover the technical content emphasized in the English and secretarial skill courses may be questionable. However, teacher-made tests with appropriate content also may be questionable due to the lack of research. It is apparent that more test development is necessary.

Another area of pre and post testing that requires comment, even though significant results were achieved, is the basic pre-college mathematics test which contained fifteen problems. The mean score was improved slightly from 9.06 to 10.35 even though very little classroom time was devoted to training in fundamental mathematics. The substantial gains shown in the pre and post mean scores (13.18 to 20.03) on the mathematics symbols test were of more relevance to the curriculum objectives and should be weighted considerably more than the mathematics problem test. Since the instructional emphasis was on higher mathematics, a pre and post test should have been used that would have evaluated higher rather than fundamental mathematics.

Also, the biology subtest of the teacher-made science test contained only six questions which was probably too short for adequate reliability and validity. The mean improvement from pre to post test in biology was 3.8 to 5.2 which was significant but subject to question due to the very limited sample.

In summary, it may be said that the testing instruments were carefully selected and well constructed and that the pre and post test results were highly positive and gave strong evidence of an effective training program. However, a careful analysis of the test results indicated that the dictation rate, percentage errors for five minute typing tests, standardized spelling test, the mathematics problem test, and the biology subtest of the science battery all had limitations serious enough to warrant some revision before being used in another similar program. All of the locally constructed tests should be refined and validated before future use.

Teachers' evaluation of the trainee's progress.

The teachers rated the trainees in December, 1966, and again in June, 1967. The teachers were asked to assign the trainees to a top, middle, and bottom third category.

The ratings by the teachers were used to calculate both final achievement level and improvement in each of the subject areas. The ratings formed the basis of the correlational and predictive studies and proved to be highly related to the test data.

Since the teachers did not know the pretest performance of each specific trainee, although they knew the mean scores of the group, it is noteworthy that the teacher ratings and the pretest results would relate so well.

An important factor in the teachers' ratings of the trainees was the increased understanding of the trainees' individual progress that developed over a period of time. The teachers kept anecdotal records and classroom test performance records on each trainee so that they could evaluate them very well. Also, the teachers' ratings indicate that the trainees who started well and were capable continued to do well and those who were very low in the beginning and were less capable found it difficult to make up their limited background in this type of training program.

Evaluation of the curriculum objectives.

The highest mean ratings were given to the curriculum objectives by the supervisors (5.4) and the lowest (4.8) was given by the Committee. The instructors mean rating was 5.3 compared to 5.1 and 5.0 by the trainees. Thus the Committee felt satisfied that the project was effective even though they were able to see areas that needed improvement. There was a high degree of consistancy in the judgment of the trainees, instructors, Committee, and the supervisors, even though some group ratings were consistently higher than others.

The overall average rating of the nineteen objectives was 5.12 (above average) on a 7 point rating scale. The science objectives were rated highest (5.6) by the total group while the mathematics objectives were rated lowest at 4.4.

When all groups were combined, the highest rated curriculum objective (6.0 mean score) was in the secretarial skills area where the goal was to develop an understanding of the need for accuracy, flexibility, tact, and patience in scientific secretarial work. The second highest rated objective (5.8 mean score) was the development of a basic knowledge of scientific terminology. The lowest rated objectives (4.2 mean) were the development of skill in preparing technical documents for the printer and the development of insight into and appreciation for advanced mathematical methods and language as these relate to scientific and technological research, including statistical analysis of data.

The evaluations suggested that the teaching of advanced mathematics and certain specific scientific tasks were too difficult to be accomplished in the time allotted during this project. Inclusion of these objectives in similar, future training programs without adequate allowance of time would be questionable. Perhaps there are certain of the required knowledge and skills which should be reserved for "advanced" training of scientific secretaries.

Trainee's evaluation of the pilot training program.

The results of the three evaluations of the instructional program by the trainees indicated that the secretarial skills area received the most excellent (E) and fewest unsatisfactory(U) ratings. This was not too surprising since it was the area the trainees knew best and in which they felt the most secure. The mathematics area was rated the lowest and there is little doubt that the trainees felt very insecure trying to understand and appreciate advanced mathematics. Science was the next to the lowest in the midterm rating but improved rapidly and was close to the top and near secretarial skills on the follow-up ratings.

In general, there were fewer E's and more S's (satisfactory) ratings given in each repetition of the evaluation. The U's decreased in June, 1967, and increased in December of 1967.

The data in Table VI, page 33, show that mathematics was rated at midterm as a problem area and became progressively worse. Science was rated at midterm as a less severe problem and improved tremendously. English was rated at midterm very well but was not as highly rated by the time of the follow-up evaluation. The secretarial skills were given consistently high ratings at each of the three evaluations.

There was a noteworthy shift in the items that received the highest number of unsatisfactory ratings. At the midterm evaluation the trainees down-rated most severely their own lack of preparation for the project while at the final evaluation they down-rated the lack of time to master the course work. Both of these items were down-rated about equally in the follow-up evaluation. It should be noted that both a lack of background and a lack of time were relatively "safe" to criticize since they did not "hurt" anyone.

The only item ratings to improve between the midterm and final evaluation were the lack of background problem and the presentation of instruction at an understandable level. The lack of background problem continued to improve but the ratings on the level of instruction decreased between the final and the follow-up evaluation. The higher June, 1967, ratings on the level of instruction may be due in part to the feedback given the instructors at midterm and the lower follow-up ratings may reflect the difficulty of retaining and using new information.

The only noticable gain in ratings between the final and follow-up evaluation occurred in the science area where the relevancy, interest, and stimulation of the course were rated higher in retrospect. The sharpest loss in rating at the follow-up evaluation occurred in regard to the relevancy of English.

The majority of the trainees (22) appeared to cope with the program on a satisfactory basis. Six experienced very slight difficulty and another six had serious difficulty. This general breakdown is fairly normal considering the research design wherein a cross section of trainees was selected for the project.

Supervisors' evaluation of trainees' progress.

The responses from the supervisors were rather difficult to secure and only about half of them felt they knew enough to rate the curriculum objectives at the March, 1967 evaluation. It was encouraging to note that they rated the project higher than the trainees, instructors, and the Committee. They agreed with the composite rating that the two weakest areas were the development of skill in preparing technical documents for the printer and the development of insight into and appreciation for advanced mathematical methods and language. Their highest ratings were given to the development of the ability to recognize errors in grammar, word usage, and syntax; the development of proficiency in taking and transcribing technical dictation; and, the development of spelling accuracy. Thus it appears that the trainees' work supervisors noticed the quickest improvement in the secretarial skills and the scientific terminology areas.

Six months after the project ended a major area of the trainees' work responsibilities reported by the employers was technical typing and technical reports which was consistent with the midterm rating of curriculum objectives. They did not appear to be adopting the title of technical or scientific secretary but they seemed to prefer to hire and promote the trainees who had completed this program. Some employers were very positive in their praise of the value of the Scientific Secretary Training Program. They mentioned the results of the project as having increased the trainees' skills, knowledge, dedication, and self-confidence. They revised the work responsibilities of the successful trainees by assigning them to laboratories, promoting them into positions of technical responsibilities and using them on technical typing and technical report assignments.

Although the number of employers who made comments was somewhat limited there was almost unanimous support for the project. They felt it was definitely a worthwhile program and wanted more areas emphasized and a longer program.

The Predictive Study

The predictive study was one of the more promising aspects of this pilot program. The multiple correlation coefficient of six pretest scores with the final rating of the trainees was .86 which was unusually high. The six scores represented spelling, verbal IQ, sentences, English expression, shorthand speed, and chemistry (Table VIII, page 44). A multiple correlation of .83 occurred between six pretest scores and the number of months trainees remained in the project (Table IX, page 44). Spelling, sentences, verbal IQ, and English expression were common scores in both of these multiple correlations.

When improvement in the four subject matter fields was correlated with ten pretest scores the resulting coefficients were also unusually high. (science = .84, mathematics = .81, English = .86, and secretarial skills = .87. See Appendices P, Q, R, and S).

The spelling score was the most highly related to five of the six measures of achievement reported above. Only the prediction of improvement in English failed to utilize the contribution of the spelling score. It should be noted here that spelling was one of the three pre and post test scores that did not show a significant improvement during the pilot project. English sentences, English expression and WAIS Verbal or total IQ scores were also highly related to five of the six measures of achievement. The chemistry subscore was related to four of the six measures of achievement while shorthand speed and the WAIS picture completion scores were related to three of the six measures of achievement.

Thus spelling and several verbal scores as well as chemistry were highly related to trainee achievement. The criteria of achievement varied considerably but the multiple correlations remained exceedingly high and the predictions based on the correlations were unusually accurate.

It is encouraging to know that the age of the trainee was not a handicap; rather,within the age limits of the trainees in this study, the older the trainee the more likely she would improve in English (r = .46) and secretarial skills (r = .50). Also, the longer the number of years of previous employment the better the chance of improvement in science (r = .35) and mathematics (r = .32). WAIS verbal and total IQ correlations with achievement were all positive and were quite useful in predicting final ratings (r = .51 and .45); the number of months trainees remained in the project (r = .42 and .38); improvement in mathematics (r = .31); improvement in English (r = .43); and the improvement in secretarial skills (r = .31) Eight WAIS subscores were of some predictive value with picture completion showing the most usefulness.

Somewhat disappointing was the relationship of high school rank percentile (HSR) to final rating (r = .31) and also the relative lack of science and mathematics predictors in the multiple regression equation. A possible explanation of the relatively low predicting value of HSR is the fact that many of the trainees graduated from high school so long ago that such data was unavailable, forgotten, or not accurately recalled. The apparent void of science and mathematics predictors may indicate that a better and most certainly longer instrument is needed in these areas and that verbal and secretarial ability as well as secretarial experience was the overwhelming factor in this training project and in the final performance and persistency rating. It can also be hypothesized that certain personality characteristics such as the degree of compulsiveness, the amount of introversion, motivation, interest and willingness to work were of more importance in this project than mathematics and science ability and background. However, there were some promising predictors of final rating that involved mathematics and science, such as: the Wechsler Information subscore (r = .48); pretest science-chemistry (20-question) subscore (r = .42); pretest five-minute statistical copy typing gwpm (r = .41); pretest total science(100-question) score (r = .37); Wechsler Digit Span subscore (r = .33); pretest science-biology subtest (r = .30); five-minute statistical copy typing errors (r = .30); Wechsler Arithmetic subscore (r = .28); and, pretest mathematics symbols test (r = .24). It is important to note that most of the above measures are subtests or short tests, and several of them are teacher-made tests that have not yet been revised on a basis of reliability and validity data. Thus, upon further analysis, it appears that some potentially useful measures of mathematics and science ability and aptitude have been identified and with additional effort could become more effective in the prediction of success in a similar training program. However, it also should be noted that the best single predictor of those trainees most likely to improve in both science and mathematics during the nine-month pilot training program was a spelling test and that the number of years of previous employment was also an excellent indicator (r = .35 and .32) of improvement in science and mathematics.

The regression equations (Tables VIII and IX; Appendices P, Q, R, and S) for predicting final performance and persistency as well as improvement in the four subject matter areas indicated that a test battery for the selection of students who can benefit most from a training program similar to the one utilized in this project should consist of some combination of tests from the following list: the DAT Spelling and Sentence test; a good verbal and quantitative intelligence test; some measure of shorthand and typing speed and accuracy; a longer and improved test in chemistry, science and math, an indication of age and the number of years of previous employment. Although overshadowed by the measures of English ability and Verbal Intelligence, it is important to note the apparent usefulness (r = .46, .40) of the fifteen-minute Minnesota Clerical Test and Name Comparison when correlated with the final performance and persistency rating in the pilot project.

It would appear that the mean scores achieved by the middle-third group of trainees (2) as reported in Table VIII (page 44) represent possible cut-scores for the selection of future trainees. Such cut-scores would probably be higher than necessary for adequate achievement and might better be used as guidelines rather than absolute criteria for admission into the training program.

Although not part of the predictive study, the findings from the survey of "medical" and "legal" secretary training programs suggest that the trainees should have a better-than-average high school achievement record and should have acquired a proficiency somewhat beyond the level of basic secretarial skills. Also, prior work experience in a scientific setting did not appear to be an important consideration in the performance of the trainees. There is no apparent evidence that reasonably high prerequisites for entrance into a specialized training program for scientific secretaries would exclude trainees with a potential for successful completion of the program.

V

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Certain conclusions, implications, and recommendations may be formulated on the basis of the findings resulting from the research and developmental activities conducted by this project. In most instances, the specific conclusions are self-evident from the results and have been incorporated in prior discussion of the analysis and interpretation of the data. They are generalized and briefly restated in this section of the report for the purpose of clarity and concise summary. Those implications and recommendations which can reasonably be inferred from the results of this study also are summarized and listed herewith.

Conclusions

It may be concluded from this study that:

1. There are identifiable special skills and knowledge required of secretaries working in a scientific setting.[1]

2. Scientific secretaries are also required to have a high degree of proficiency in the typical, general knowledge and skills required of other secretaries; such as typing, shorthand, spelling, and punctuation.

3. There is a current and increasing national requirement for specially trained individuals to provide supporting secretarial services for scientists and engineers in the rapidly growing scientific and technological facet of our nation's economy.

4. At the present time, most scientific secretaries must rely upon their own individual study or upon in-service orientation or training provided by their employers to obtain the special knowledge and skills required in their work.

5. An adequate curriculum for a formalized, class instruction program based on the specialized, educational needs of scientific secretaries should be offered at least at the post-secondary school level and should consist of no less than 320 clock hours of class instruction and skills practice (cf. recommendations concerning desirable scheduling).

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[1] Note: See Section III of this report for detailed descriptions of special educational needs of scientific secretaries.

6. The kinds of specialized instructional staff, materials, equipment, and facilities required to offer a formalized training program for scientific secretaries would appear to be within the personnel and fiscal capability of most existing community colleges, area vocational schools, colleges, and universities.

7. Adult women of varying ages with intellectual capability and formal education above that of the average national adult population can and do significantly increase their knowledge and improve their skills by participating in a formalized training program designed to meet the specialized educational needs of scientific secretaries.

8. Achieving appreciation for and understanding of advanced mathematical processes is the area of study of greatest difficulty and dissatisfaction for these students, due primarily to their inadequate prior formal educational experience and resultant lack of interest in this field.

9. The increased knowledge and improved skills achieved by these students in a formalized training program do improve their proficiency as secretaries working in a scientific setting and enhance their employability and advancement.

10. It appears possible to predict with considerable accuracy the degree of success which adult women will achieve in a formalized training program for scientific secretaries.

11. Although further refinement and validation is needed, the criteria identified and the predictive instruments used in this study may be utilized with some confidence in the selection and assignment to instructional levels of trainees in a scientific secretary training program similar to the one conducted by this project (cf. recommendations for refinement and validation.)

Implications

The results obtained and the conclusions reached in this study suggest that some modifications in existing educational and science-related research and business practices may warrant consideration by those persons directly concerned.

1. A matter of general concern is that the current need for more adequately trained scientific secretaries, as reported by employers, implies that many highly trained scientists and engineers may not be able to make the fullest use of their talents in the discovery and application of scientific knowledge.

2. The fact that most scientific secretaries must rely on their own individual study or on industry sponsored in-service training to acquire needed knowledge and skills suggests that established educational institutions and agencies should begin at once to utilize their capabilities in meeting an important educational need -- both with reference to pre-service training of youth and in-service retraining of adults.

3. The wide variance and inadequacy of background in mathematics and science acknowledged by the respondent secretaries who are currently working in scientific settings warrants consideration of the development of an individual systems approach for in-service training of scientific secretaries in these important subject areas.

4. The increasing specialization and complexity of tasks in science-related endeavors suggests that the competencies required of scientific secretaries will follow suit; thereby implying the need for developing differentiated (but articulated) levels of training corresponding to the patterns of specialized work assignments to be developed by employers. Eventually, the top-ranked scientific secretary positions may required training comparable to a bacculaurate degree.

5. Educational institutions engaged in general secretarial training, including secondary schools, might well consider developing introductory units of instruction to provide initial orientation to secretarial work in a scientific setting and to stimulate interest in seeking further training and employment in this field. The early identification of an individual's ability and interest in science and mathematics and potential application in secretarial work is implicit.

6. The clearly different qualifications required and the special nature of work assignments of scientific secretaries suggests that both private enterprise and governmental personnel systems should develop appropriate job classifications, with commensurate compensation, for this specialized type of employment.

Recommendations

In general, the results of this study indicate that a formalized class instruction program of the type conducted in the pilot training project is successful in increasing the knowledge, skills, and on-the-job proficiency of the individuals so trained and that their success in completing such a training program can be predicted with reasonable accuracy. However, the evaluation of this pilot project also reveals certain needed improvements which are incorporated in the following recommendations. In comtemplation of offering a similar training program, it is recommended that:

1. A more homogenous grouping of trainees should be achieved by administering the predictive test battery in advance and by making the assignments to particular group levels in accord with the test results.

2. Either the schedule should allow more time for remedial or refresher work to bring the trainees' basic typing and shorthand skills up to a satisfactory level or a recommended minimum, demonstrated skill of 50 wpm in typing and 80 wpm in shorthand should be established as a prerequisite.

3. A class schedule for individuals who have full-time employment probably should not exceed five hours of in-class instruction per week and should be correspondingly extended to 64 weeks in length (or approximately the equivalent of four semesters, rather than two semesters) with the understanding that some out-of-class preparation also will be required. (This recommendation should not be construed as indicating a preference for this type of schedule over the ten hour per week schedule for 32 weeks which is believed to be a satisfactory schedule for persons who do not have full-time employment.)

4. Either some provision should be made for individual, supervised study time in addition to the 320 clock hours of in-class instruction and skills practice or it should be understood that a normal amount of "homework" will be required. (It is not possible to recommend a uniform requirement for out-of-class preparation but, based on the experience of this project, it seems reasonable to suggest that a student with average ability should expect to spend about one hour in outside preparation for each hour spent in class.)

5. Closer integration of the instruction in the science and mathematics areas with the secretarial skills areas can be achieved through allowing the instructors adequate time for advance planning and preparation of dictation and typing exercises which are closely related to or directly taken from the material to be studied in sequence in science and mathematics. (This would be a more desirable and realistic procedure to assure close integration of instruction rather than anticipating that instructors can be given sufficient time for planning and preparation of integrated instructional materials as the program progresses.)

6. The emphasis of instruction in mathematics should not include any attempt to develop actual manipulative ability in algebra, trigonometry, or any other advanced mathematical processes but should, rather, emphasize a purely qualitative understanding of the various branches of mathematics and their importance to scientific work and a practical study of the meaning and significance of a broad range of mathematical nomenclature and symbolism. Emphasis on fundamental arithmetic and accuracy is also recommended.

7. The locally prepared pre and post tests should be given item analysis and be revised accordingly to increase validily and reliability. More specifically; a) the biology test should be lengthened to include at least 20 relevant questions, b) the mathematics test should be revised to include more questions concerning understanding of mathematical nomenclature and symbolism, and c) the five minute straight copy and the five minute statistical copy typing tests should be revised to include material more directly related to the curriculum and selected at a higher level of difficulty.

8. The Cooperative Mechanics of Expression test should be replaced by a similar test which has a higher ceiling and more comparable alternate forms.

9. In addition to the DAT Spelling test, a comparable spelling test with appropriate technical content and alternate forms should be utilized to supplement the evaluation of spelling improvement.

10. A formula or procedure should be developed to represent the simultaneous improvement in wpm and percentage error in typing and shorthand transcription. The weighted wpm used to relate dictation and transcription rate used in this study is an example of such a formula.

VI

SUMMARY

The problem in this project was to determine whether or not there are special skills and knowledge required of the secretary working in a scientific setting and, if so, to determine whether or not an instructional program specifically designed to meet the specialized educational needs of scientific secretaries would, in fact, provide these skills and knowledge to persons with appropriate ability and motivation. The problem of determining criteria for successful completion of such an instructional program also was studied.

The following objectives were established for the project:

1. to determine the educational needs of those persons working as scientific secretaries in relation to the requirements of their employers;

2. to develop an instructional program to meet the educational needs of scientific secretaries;

3. to conduct a pilot training program to test the adequacy of the instructional program, including a follow-up evaluation of the trainees' on-the-job performance; and,

4. to determine the criteria and evaluative instruments for predicting the success of persons to be trained for employment as scientific secretaries.

The educational needs of scientific secretaries were determined through:

1. a review of the related literature;

2. a survey of existing specialized secretarial training programs; and,

3. observations, interviews, and a questionnaire study involving secretaries, scientist supervisors, and personnel managers in 118 science-related organizations in 25 different states and the District of Columbia. The crucial tasks performed by scientific secretaries, as identified in this study, were used as the basis for developing the objectives, content, methods, and materials for the pilot training program.

Forty-six voluntary trainees for the pilot training program were recruited and selected on the basis of characteristics of adult students who would be likely to participate in future, similar programs. A pilot training program consisting of 320 clock hours of in-class instruction and skills practice was conducted over a period of 32 weeks from September 27, 1966, through June 3, 1967. The pilot program was evaluated on the basis of the trainees' improvement in knowledge and skills and their on-the-job performance. The evaluative procedures included:

1. comparison of the trainees' performance on a battery of pre and post tests;
2. teachers' evaluations of the trainees' achievement;
3. trainees' evaluations of the instructional program; and
4. trainees' work supervisors' evaluations of the instructional program and the trainees' on-the-job performance (conducted six months after completion of the pilot training program).

Identification of criteria for the prediction of success in the pilot training program was accomplished through comparisons of the trainees' performance on the pre and post test battery, teachers' evaluation of trainee achievement, and selected trainee characteristics. The data gathered in the study were treated according to accepted procedures for descriptive, comparative, and predictive analyses and included the computation of rank orders, percentages, correlation coefficients, significant differences, multiple correlation, and multiple regression equations, as appropriate to the research design.

Related literature in this new area of secretarial education was found to be limited but indicated a recognition of the need for specialized training for secretaries working in scientific settings and a lack of available educational programs for persons seeking special training as scientific secretaries.

The observations, interviews, and questionnaire responses of secretaries, scientist supervisors, and personnel managers in science-related organizations clearly indicated that certain crucial tasks performed by scientific secretaries required special training not generally included in current secretarial education curricula. More specifically, the respondents indicated that scientific secretaries have special educational needs for developing knowledge and skills in:

1. basic, general science;

2. scientific and technical terminology;
3. mathematics;
4. technical typing (equations, symbols, and formulas);
5. technical shorthand.

The respondents also indicated a need for scientific secretaries to develop a high degree of proficiency in the basic secretarial skills and use of the English language.

Curriculum guides, including objectives, units of instruction, teaching methods, and instructional materials were developed in the instructional areas of basic science, mathematics, secretarial skills, and English. A schedule of ten hours per week of in-class instruction and skills practice extending over a period of thirty-two weeks was adopted for the pilot training program. Approximately four and one-half hours of instruction per week were allocated to the area of secretarial skills, three and one-half hours per week to instruction in basic science, and one hour per week was allocated to each of the mathematics and English instructional areas. The trainees were divided into two groups, based on their demonstrated proficiency in typing and shorthand skills, for purposes of facilitating group instruction.

The trainees were all women who had completed a minimum of a high school education and possessed at least marketable secretarial skills. Variations in the trainees' ages, years of secretarial work experience, level of formal education, and type of employment represented a reasonable cross section of adult women who might seek specialized training as scientific secretaries, including thirteen trainees who were currently employed in a scientific setting. As a group, the trainees' possessed above-average general intelligence in relation to the national population but were far below an average college freshman class in scholastic achievement related to mathematics and science.

In general, the trainees achieved significant improvement in their knowledge and skills as a result of their experience in the pilot training program. Sixteen of the twenty pre and post test measures reached the .05 level of significant improvement. Outstanding gains were achieved in rough draft typing, dictation-transcription weighted wpm, mathematics symbols, and total science scores. The teachers' evaluations of the trainees' achievement according to groupings based on the top, middle, and bottom thirds of the total group indicated that twenty-seven of the thirty-four trainees who completed the program attained a level of achievement clearly adequate for satisfactory to good performance as a scientific secretary. The remaining seven trainees achieved a level of performance which seemed questionable in terms of satisfactory performance as a scientific secretary, although these trainees did improve their knowledge and skills and might well function adequately as technical typists. The trainees' evaluation of the pilot training program showed generally satisfactory to excellent ratings for teaching methods and relevancy of content in all instructional areas. However, strong dissatisfaction was expressed by the trainees with regard to their own previous background in science and mathematics and the lack of instructional time in the area of mathematics. The trainees' work supervisors who responded to the evaluation of the pilot program curriculum objectives indicated a high degree of accord with the overall objectives and they were most satisfied with the achievement of the English curriculum objectives and least satisfied with the mathematics curriculum objectives. The supervisors who responded in the six-month follow-up evaluation of the pilot training program were in general agreement that the trainees' had improved in their overall on-the-job performance where observation of comparable pre and post training performance was possible. Where comparable observation was not possible, the supervisors nevertheless indicated that the training experience had enhanced the trainees' employability and possibility for career advancement.

With admitted reservations concerning revision and validation of the predictive instruments used, it was found that successful completion of a training program similar to the one conducted in this study can be predicted with a high degree of accuracy. One six-variable multiple correlation with four levels of final achievement resulted in a multiple correlation (R) of .86 with a standard error of estimate (S.E.) of .604. Measures of secretarial knowledge and skills proved to be much better predictors than measures of knowledge in science and mathematics. Level of achievement measure by the DAT Spelling test and verbal IQ as measured by the Wechsler Adult Intelligence Scale were fould to be two of the best predictors in terms of multiple correlation with final achievement levels.

The main conclusions related to the research design were:

1. the special educational needs of scientific secretaries can be identified;

2. a training program based on these special educational needs can be developed and conducted and does result in improved knowledge, skills, and on-the-job performance on the part of adult, women trainees of above-average intelligence;

3. it appears possible to predict accurately the degree of success which adult women will achieve in such a specialized training program.

Among the more significant implications for modification of existing educational and business practices cited were:

1. there is an increasing need for programs to train scientific secretaries which is not being met by established educational institutions;
2. an individual-study approach to providing in-service training in science and mathematics for currently employed scientific secretaries warrents consideration;
3. both private enterprise and governmental personnel systems should develop job classifications for scientific secretary positions;
4. eventually, top-ranked scientific secretaries may require up to four ears of post-secondary school education.

Specific recommendations for improvement in the selection and grouping of trainees, scheduling, integration of instruction, emphases in mathematics, and the refinement and validation of predictive instruments also were formulated.

APPENDIX A

Catalog Descriptions of Existing Technical Training Programs

Bryant & Stratton Business Institute, Buffalo, New York
Technical Secretary

"In an age of expanding technology and emphasis on science, a demand exists for well-trained technical secretaries. The Niagara Frontier, as well as other areas, offers countless opportunities for the secretary who can use, understand, and interpret the terminology of the scientists or engineers in such fields as electronics, chemistry, aerodynamics and nuclear physics."

Time - 50 weeks (program may be cut to 40 weeks if the student has already completed two or more years of shorthand and typewriting.)

Term One:	hrs. week
Shorthand I	10
Business English	5
Secretarial Typewriting	10

Term Two:	hrs. week
Shorthand II	10
Communications in Bus.	5
Secretarial Typewriting	5
Nancy Taylor	5

Term Three:	
Dictation-Transcription	10
Secretarial Typewriting	5
Secretarial Mathematics	5
Secretarial Accounting	5

Term Four:	
Shorthand-Transcription	10
Secretarial Typewriting	5
Office Practice	5
Secretarial Accounting	5

Term Five:	
Technical Dictation-Trans.	10
Technical Typewriting	5
Science of Math and Blueprint Reading	5
Report Writing	5

Technical Dictation and Terminology - terminology used in several scientific areas is practiced for meaning, spelling, and use. Typical dictation includes scientific reports, memos, and letters.

Technical Typewriting - covers techniques required for correct presentation of math symbols, equations, chemical formulas, engineering graphs and schematics.

Science of Mathematics and Blueprint Reading - covers the basic ideas of algebra, trigonometry, analytic geometry, and calculus, as well as the symbols used to express them. Defines concepts such as number, abscissa, parabola, quantification, logarithms, locus, and the basic priciples of engineering drafting.

Report Writing - covers the manual, the article, the report, the proposal, technical advertising, the technical movie, and writing an original report.

Central City Business Institute, Syracuse, New York
Engineering Secretary (48 wks.)

Term One:	hrs. week	Term Two:	hrs. week
Modern Communications	5	Modern Communications	5
Secretarial Accounting	5	Secretarial Accounting	5
Introd. to Engineering	5	Engineering Mathematics	5
Shorthand Theory	5	Shorthand Theory	10
Typing Technique	5	Typing Technique	5
Term Three:		Term Four:	
Modern Communications	5	Modern Communications	5
Engineering Laboratory	5	Business Psychology	5
Dictation-Transcription	15	Engineering Laboratory II	15
Typing Technique	5	Dictation-Transcription	15
		Nancy Taylor	3

Engineering Laboratory I and II - deal with actual problems which call for advanced knowledge of centering and tabulation techniques; the typing of engineering reports and other technical material containing mathematical equations on specially designed IBM typewriters; and dictation of letters and other material pertaining to the engineering profession.

Engineering Mathematics - includes mathematical signs, symbols, graphs, and use of mean, median and mode; reading of FHA and VA specifications, blueprints, palns, architects' renderings; use of the slide rule for multiplication, division, square roots and cube roots; a review of algebraic terms, equations and expressions; a review of 50 facts in geometry; finding the area of various geometric figures; and trigonometry and the use of sin., cos., and tan.

Colby Junior College, New London, New Hampshire
Technical Secretary (two years)

Year One:	sem. hrs.	Year Two:	sem. hrs.
Communications	6	English electives	6
General Chemistry	8	Physics	4
Shorthand	3	Accounting	3
Dictation-Transcription	3	Secretarial Procedures	6
Typewriting	6	Technical Dictation	6
Electives	6	Electives	6
Physical Education	2	Physical Education	2

Technical Dictation - terminology in the fields of science and technology are introduced in this course. Through dictation and transcription of subject matter related to chemistry and physics, the student develops the accuracy, speed, and vocabulary that enables her to meet the stenographic requirements of technical organizations.

Candidates for this curriculum at Colby Junior College must present at least one year of a laboratory science and three years of mathematics in their secondary school work.

Grace Ball Secretarial College, San Francisco
Electronics Technical Secretary (one year)

Term One:	Units	Term Two:	Units
Shorthand	5	Dictation-Transcription	5
Typing	2	Typing	4
Accounting	3	Accounting	1
Word Study	1	Payroll	1
Filing	2	Word Study	1
Math. Review	1	Business Dictation	5
Office Machines	2		

Term Three:		Term Four:	
English	3	Economics	3
Business Dictation	5	Survey	3
Typing	2	Business Dictation	5
Secretarial Studies	4	Business Correspondence	2
Office Practice	1	New Dictation	1
New Dictation	1	Duplicating Processes	1

Term Five:			
Manuscript Typing	3	Survey	3
Data Processing	2	Charm	1
Electronics Dictation	5		

Survey - covers the fundamentals of the electronics and scientific fields with concentration on such specifics as: terminology, symbols, equations, special office forms, charts, graphs, basic blueprint reading, departmental budget preparation and special reports.

Manuscripts - practice in setting up, proofreading, rough drafts, and final copies of manuscripts and reports as they will be encountered in office work.

Keystone Junior College, La Plume, Pennsylvania
Technical Secretary (4 sem.)

First Semester:	Crs.	Second Semester	Crs.
Personal Finance	3	English	3
Engineering Drawing	2	Mathematics	3
English	3	Shorthand	3
Mathematics	3	Typing	2
Shorthand	3	Electives	6
Typing	2		
Third Semester:		**Fourth Semester:**	
Blueprint Reading	1	Office Management	3
Physics	4	Speech	3
Shorthand	3	Communications	3
Typing	2	Physics	4
Office Machines	1	Engineering Trans.	3
Economics	3		
Elective	3		

Point Park Junior College, Pittsburgh, Penn.
Engineering Secretary (4 trimester)

First Trimester:	hrs. week	Second Trimester:	hrs. week
English Composition	3	English Composition	3
General Science	3	Shorthand (eng.)	6
Mathematics	3	Typewriting	6
Slide Rule	1	Engineering Drawing	4
Shorthand	5	Electives	6
Typewriting	5		
Physical Education	1		

Third Trimester:

Business Communications	3
Psychology	3
Shorthand (eng.)	3
Typewriting	5
Transcription (eng.)	5
Accounting	3

Fourth Trimester:

Literature	3
Shorthand (eng.)	5
Transcription (eng.)	5
Secretarial Duties	3
Elective	3

Engineering Drawing - Interpretation of drawings and symbols; American standard drafting room practices. Course includes a general survey of the functions and capabilities of various shop machines, such as the lathe, mill, shaper, planer, drill press, surface and cutter grinder.

Engineering Dictation - Development of technical vocabulary and shorthand for mechanical, electrical, and electronic engineering.

Engineering Transcription - includes introduction to technical report styles.

"The Engineering Secretarial Major is a professional program designed to prepare young men and women to understand engineering and scientific terminology, to take dictation at high speeds, and to perform basic laboratory work."

Broome Technical Community College, Binghamton, New York
Engineering Secretary

Term One:

English	3
Psychology	3
Mathematics	3
Typing	2
Shorthand	3
Accounting	3

Term Two:

English	3
Physics	3
Typewriting	2
Shorthand	3
Business Math.	3
Accounting	3

Term Four:

Chemistry	4
Technical Shorthand	3
Sociology	3
Payroll Accounting	3
Engineering Drawing	1
Personnel Administration	3

Term Five:

Effective Speaking	3
Data Processing	3
Technical Shorthand	3
Business Law	3
Shop	2
Office Practice	3

Term Three:	
English	3
Physics	3
Typewriting	3
Shorthand	3
Transcription	3
Accounting	3

Term Six:	
Economics	3
Business English	3
Shorthand	3
Office Practice	4
Business Law	3
Industrial Organization and Management	3

Physics - Heat and sound; mechanics; electricity; light; modern physics.

Chemistry - for non-technical students, explaining basic laws, principles, and theories. Topics include structure of matter, chemical behavior, states of matter, solutions, and elements of organic chemistry. The laboratory experiments are illustrated by the instructor rather than practice by the student.

Technical Shorthand - Emphasis on increasing technical vocabulary. Dictation and transcription of technical material from the fields of scientific research and engineering. Dictation at 70 to 90 wpm.

Engineering Drawing - A basic drafting course specifically designed for business students.

Shop - Observation and discussion of the machines and materials used in industry to produce machines, appliances, containers. Practice in processing metals, leading to acquaintance with technical and shop terms and a knowledge of what is done in machine shops.

Cerritos College, Norwalk, California
Technical Secretary

First Semester:	
Business Communications	3
Intermediate Typing	3
Intermediate Shorthand	4
Personnel Relations	3

Second Semester:	
Business Communications	3
Personal Finance	3
Intermediate Typing	3
Managerial Office Systems	2
Intermediate Shorthand	4
Filing	1

Third Semester:	
Health Education	2
Advanced Typing	3
Advanced Shorthand	3
Technical Secretary	4

Fourth Semester:	
American History	3
American Institutions	3

Fourth Semester (cont.):

Office Machines	2
Technical Secretary	4

Technical Secretary - Development of technical shorthand vocabulary; training in spelling, pronunciation and definitions of technical vocabulary, including emphasis on the airplane industry, missiles, electronics, petroleum, nuclear physics and chemistry, data processing, engineering, mathematics, and science. Second semester will include instruction in technical typing, including typewriting of engineering symbols, mathematical signs and rough drafts, with particular emphasis on handbooks of a specialized nature. Special training is given in technical secretarial and office procedures.

APPENDIX B

Confidential Questionnaire for Secretaries

General Information

Employing Organization Name ______________________________

Address ____

Principal Product ____________ Scientific Field ____________

Check Type: Government _____ Industry _____ Education _________

Is this organization involved in Research? _____ If yes, Applied _____ Basic _____

Approximate number of employees ______________ ______________
(total company) (your department)

Approximate number of secretaries ______________ ______________
(total company) (your department)

Title of your present position ____________________________
Starting Date ________________

Do you have a GS rating _____? If yes, what is it ___________?

Are you in a stenographic pool _____? Number of secretaries in your office _____

Sex: F ___ M ___ Age: (circle one) Below 20, 20-24, 25-29,
30-39, over 40

Marital status: Single _____ Married _____ Divorced _____ Widowed _____

If married, what is occupation of spouse? ___________________

Educational status of spouse: (circle highest) High School 9 10 11 12
College 1 2 3 4 5 6 7 8

Title(s) of your supervisor(s) ____________________________

____

What percent of time does your immediate supervisor(s) spend in the

Research Lab ____% Teaching ____% Administration ____%

(Other) ____________ ____% ____________ ____% ____________ ____%

Your Previous Work Experience (List Most Recent Job First)

Title of Firm	Title or Type of Work	Date		Monthly Pay	Part or Full Time
		From	To		

Educational Background

Type of School	Circle Highest Completed	Area of Emphasis	Name of Degree, Diploma, Certificate
High School	Grade 9 10 11 12		
Post H.S. Night School	Years 1 2 3 4		
On-the-Job Training	Weeks 1 4 8 Other___		
Business College	Mos. 1 6 12 18 24		
Vocational College	Years 1 2 3 4		
Junior College	Years 1 2		
University or College	Years 1 2 3 4		
Graduate School	Years 1 2 3 4		
Other______________	Years 1 2 3 4		
Other______________			

What specific courses taken in high school or elsewhere have been most helpful in your present position?

Name of Course	Type of School
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

What other courses do you wish you had taken?

______________________ ______________________

______________________ ______________________

What specific courses in science and mathematics have you had?

______________________ ______________________

______________________ ______________________

Did you enjoy these math and science courses? ____________________

Through what method did you obtain your present position? Check (✓)

____ Promotion within organization ___Relative ___Employment Agency

____ School Placement Office ___Newspaper ad ___Referral (by whom)__________

Other____

What specifically made you interested in applying for the particular position you now have?

____

____

Below are listed job activities you may perform. Please check (✓) the apprepriate column to indicate frequency, value to your supervisor, and need for knowledge of science and terminology.

	Frequency				Value to your Supervisor			Science	
	Daily	1-29 times/month	1-11 times/year	Never	Essential	Moderate	Small	Would a knowledge of science & terminology help you in this work?	
	D	M	Y	N	E	M	S	Yes	No
I. General Clerical and Office Management									
A. Communications.	____	____	____	____	____	____	____	____	____
(1) Perform routine telephone duties.	____	____	____	____					
(2) Use a foreign language (What?)____________________	____	____	____	____					
(3) Handle foreign correspondence	____	____	____	____					
(4) Other (specify)____________________	____	____	____	____					
B. General Clerical.	____	____	____	____	____	____	____	____	____
(1) Compose routine letters	____	____	____	____					
(2) Requisitions for technical equipment.	____	____	____	____					
(3) Accounting or financial duties.	____	____	____	____					
(4) Prepare material for printer.	____	____	____	____					
(5) Proofread from technical copy	____	____	____	____					
(6) Edit manuscripts and speeches	____	____	____	____					
(7) Search patent records	____	____	____	____					
(8) Other (specify)____________________	____	____	____	____					
C. Filing.	____	____	____	____	____	____	____	____	____
(1) Keep ordinary files	____	____	____	____					
(2) Set up your own filing system	____	____	____	____					
(3) Keep MeBee (punch) file	____	____	____	____					

	Frequency				Value to your supervisor			Science	
	Daily	1-29 times/month	1-11 times/year	Never	Essential	Moderate	Small	Would a knowledge of science & terminology help you in this work?	
	D	M	Y	N	E	M	S	Yes	No
(4) Keep bibliographic file	___	___	___	___					
(5) Keep classified file.	___	___	___	___					
(6) Keep files of current research.	___	___	___	___					
(7) Keep reprint and preprint files	___	___	___	___					
(8) Classify incoming scientific data	___	___	___	___					
(9) Librarian of scientific periodicals and books	___	___	___	___					
(10) Other (specify)______________________________	___	___	___	___					
D. Records	___	___	___	___	___	___	___	___	___
(1) Keep project records and progress reports	___	___	___	___					
(2) Other (specify)______________________________	___	___	___	___					
E. Office Management	___	___	___	___	___	___	___	___	___
(1) Supervise others (No. of people under you_____)	___	___	___	___					
(2) Other (specify)______________________________	___	___	___	___					
II. Contact with People (face to face)									
A. Contact with People	___	___	___	___	___	___	___	___	___
(1) Act as receptionist	___	___	___	___					
(2) Act as business hostess	___	___	___	___					

	Frequency				Value to your supervisor			Science	
	Daily	1-29 times/month	1-11 times/year	Never	Essential	Moderate	Small	Would a knowledge of science & terminology help you in this work?	
	D	M	Y	N	E	M	S	Yes	No
(3) Explain,scientific projects to inquirers	___	___	___	___					
(4) Attend staff meetings.	___	___	___	___					
(5) Attend colloquia or conventions.	___	___	___	___					
(6) Make field trips to related organizations.	___	___	___	___					
(7) Other (specify)________________________________	___	___	___	___					

(8) What percent of your working time is spent:
Alone__________ With secretaries__________ In meetings_____ Business trips_____
With supervisor(s)_____ With other staff_____ With visitors_____ Other_________

III. Secretarial Skills

A. Use typewriter (manual_____ electric_____)	___	___	___	___	___	___	___	___	___
(1) Use typewriter with interchangeable keys.	___	___	___	___					
(2) Use typewriter with scientific symbols.	___	___	___	___					
(3) Use typits.	___	___	___	___					
(4) Other (specify)________________________________	___	___	___	___					
(5) Your average typing speed on straight copy is _____WPM. . . .	___	___	___	___					
(6) Your average no. of errors on straight copy is _____per page.	___	___	___	___					
B. Typing Activities.	___	___	___	___	___	___	___	___	___
(1) Type routine material from rough draft.	___	___	___	___					
(2) Type scientific (math) handwritten notes.	___	___	___	___					

	Frequency				Value to your supervisor			Science	
	Daily	1-29 times/month	1-11 times/year	Never	Essential	Moderate	Small	Would a knowledge of science & terminology help you in this work?	
	D	M	Y	N	E	M	S	Yes	No
(3) Type statistical and tabulated data	_	_	_	_					
(4) Type technical (scientific) reports	_	_	_	_					
(5) Type in a foreign language.	_	_	_	_					
(6) Type coded instructions for data processing	_	_	_	_					
(7) Type copy for photoreproduction	_	_	_	_					
(8) Type manuscripts for publication.	_	_	_	_					
(9) Type charts or graphs	_	_	_	_					
(10) Type schematics or blueprints	_	_	_	_					
(11) Type scientific (Math) formulae	_	_	_	_					
(12) Type scientific symbols or abbreviations.	_	_	_	_					
(13) Type subscripts, superscripts, or prescripts.	_	_	_	_					
(14) Type math or scientific equations	_	_	_	_					
(15) Type matrices or tables	_	_	_	_					
(16) Type Greek letter symbols	_	_	_	_					
(17) Type metric system prefixes	_	_	_	_					
(18) Type research grant proposals	_	_	_	_					
(19) Other (specify)________________________________	_	_	_	_					
C. Dictation and Transcription Skills & Activities.	_	_	_	_	_	_	_	_	_
(1) Take dictation direct at typewriter	_	_	_	_					
(2) Take dictation from more than one supervisor.	_	_	_	_					

	Frequency				Value to your supervisor			Science	
	Daily	1-29 times/month	1-11 times/year	Never	Essential	Moderate	Small	Would a knowledge of science & terminology help you in this work?	
	D	M	Y	N	E	M	S	Yes	No
(3) Use transcribing machine.	___	___	___	___					
(4) Transcribe from supervisor's notes.	___	___	___	___					
(5) Take technical dictation.	___	___	___	___					
(6) Transcribe technical materials.	___	___	___	___					
(7) Other (specify)______________________________	___	___	___	___					
(8) What is your average shorthand speed? _____WPM.									
(9) Average no. of errors per page _____?									
(10) Your average transcribing speed from transcribing machine is _______WPM?									
(11) Average no. of errors per page______?									
D. Office Machine Skills.	___	___	___	___	___	___	___	___	___
(1) Use adding machine.	___	___	___	___					
(2) Use calculator.	___	___	___	___					
(3) Use stencil and spirit duplicating machine.	___	___	___	___					
(4) Do contact duplicating.	___	___	___	___					
(5) Use posting and billing machine	___	___	___	___					
(6) Use offset printing machine	___	___	___	___					
(7) Other (specify)______________________________	___	___	___	___					

	Frequency				Value to your supervisor			Science	
	Daily	1-29 times/month	1-11 times/year	Never	Essential	Moderate	Small	Would a knowledge of science & terminology help you in this course?	
	D	M	Y	N	E	M	S	Yes	No
E. Data Processing Skills.	___	___	___	___	___	___	___	___	___
(1) Act as keypunch operator.	___	___	___	___					
(2) Operate key driven machines	___	___	___	___					
(3) Operate card sorting machine.	___	___	___	___					
(4) Operate collating machine	___	___	___	___					
(5) Operate bookkeeping machine	___	___	___	___					
(6) Operate tabulating machine.	___	___	___	___					
(7) Act as tape clerk or tape librarian	___	___	___	___					
(8) Do coding	___	___	___	___					
(9) Prepare input for machines.	___	___	___	___					
(10) Trace exceptions on machines.	___	___	___	___					
(11) Other (specify)___________________________________	___	___	___	___					
F. Organizing and Analyzing Data	___	___	___	___	___	___	___	___	___
(1) Make abstracts of journal articles.	___	___	___	___					
(2) Write summaries of supervisor's research.	___	___	___	___					
(3) Use specialized dictionaries.	___	___	___	___					
(4) Edit (or write) technical reports	___	___	___	___					
(5) Do research in the library.	___	___	___	___					
(6) Assemble data for technical reports	___	___	___	___					
(7) Review trade publications for supervisor.	___	___	___	___					

	Frequency				Value to your supervisor			Science	
	Daily	1-29 times/month	1-11 times/year	Never	Essential	Moderate	Small	Would a knowledge of science & terminology help you in this work?	
	D	M	Y	N	E	M	S	Yes	No
(8) Compile summaries of published data	___	___	___	___	___	___	___		
(9) Make annotated bibliographies	___	___	___	___					
(10) Collect or organize technical or statistical data	___	___	___	___					
(11) Calculate technical or statistical data	___	___	___	___					
(12) Prepare graphs or charts of data.	___	___	___	___					
(13) Write formulae and technical symbols in longhand.	___	___	___	___					
(14) Other (specify)______________________________	___	___	___	___					

General Questions

(1) To which of the following services (departments) do you refer work. Please check (✓).

___ Duplicating ___ Data Processing ___ Purchasing Dept. ___ Editing
___ Graphics ___ Photography Dept. ___ Translating Dept. ___ Publications
___ Other __________ ___ Other __________ ___ Other ____________________

(2) What specific technical references do you use?

Name	Author
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________

(3) Please check (✓) the fields in which you can spell scientific terms without frequent use of a dictionary and decipher the correct term from context in hastily handwritten memos or rough draft.

___ Aeronautical
___ Agricultural
___ Astrophysics
___ Astronomy
___ Biochemistry
___ Biology
___ Biophysics
___ Chemical Engineering
___ Chemistry
___ Civil Engineering
___ Cryogenics
___ Cybernetics
___ Elect. Engineering
___ Electronics
___ Geology
___ Geophysics
___ Mechanical Engineering
___ Metallurgy
___ Meteorology
___ Oceanography
___ Pharmaceuticals
___ Physics (Atomic Nuclear)
___ Radio (Communication)
___ Other ________________

(4) In which of the following would further study be of value to you in your work? (✓)

___ Biology
___ Chemistry
___ Computer Science
___ Earth Science
___ General Scientific Terms
___ Specific terms in your scientific area
___ Mathematical Expressions (symbols)
___ Oceanography
___ Philosophy of Science
___ Physics and Electronics
___ Space and Astronomy
___ Technology and Engineering
___ Other (specify) ________________
___ Other (specify) ________________

(5) Do you consider your position:
___ Permanent ___ Temporary ___ Other (specify) ___________
Does your position provide opportunity for promotion? ____________________

(6) Describe briefly and give the title of the next higher position in your organization.
____
____

(7) For your position do you consider yourself trained:
___ Inadequately ___ Adequately ___ Overly

(8) Is previous work experience in your scientific area a prerequisite for this position?

____

Critical Comments

(1) The ideal secretary in your position, in order to be highly successful, is required to do a number of crucial tasks. Please list and then rank (Assign nos. 1, 2, 3, etc.) the most critical tasks.

Rank #	Task	Rank #	Task

(2) The ideal secretary in your position, in order to be highly successful, is required to possess certain crucial traits. Please identify by name and give a concrete illustration or example of each critical trait.

(3) The ideal secretary in your position, in order to be highly successful, is required to have certain crucial skills and knowledge. In your opinion, which of these skills are most important? Please list and rank them in order of importance.

Rank #		Rank #	

(4) If you could change yourself to be "Ideal" for your present position, what would you most like to change?

(5) As a secretary in a scientific organization, what specifically do you think you do that someone in a similar position working in a non-scientific firm probably would not do?

(6) Would specialized training for scientific secretary work have been of any value before you accepted your first scientific secretarial position?
YES ___ NO ___

Would further training in scientific secretarial work be of value to you now?
YES ___ NO ___

(7) What advantages would a scientific secretary training program have given you?

(8) What type of courses and training would you recommend from your experience as a scientific secretary?

(9) Additional comments you may wish to make:

Thank you for your help and consideration.

Your name and address (optional):

Scientist Supervisor's Biographical Data Form

Name of Organization____

Address____

Principal Product______________ Scientific Field________________

Check type of organization: Govt.____ Industry____ Education_____

Is this organization involved in basic ___or applied ___ research?

Approximate number of employees ______________ ______________
(total company) (your department)

Approximate number of secretaries ______________ ______________
(total company) (your department)

What is your title?____

What advanced degrees do you hold? _____ ______________________
_____ ______________________
(degree) (field)

How many employees do you supervise:
In research jobs________________
In secretarial jobs_____________

What percent of your time is spent in:
Research lab______ Administration______________
Teaching__________ Advising or Consulting_______
Other (specify)____
Other (specify)____

1. What types of activities does your secretary spend most of her time doing on the job?

2. In thinking back over the different secretaries who have worked for you, would you think of both the worst one and the best one you've ever had, and indicate below what it was that made them either the worst or the best in terms of the following three criteria:
   a) their performance of the crucial tasks required in their jobs;
   b) their possession of the crucial traits necessary to their jobs; and
   c) their grasp of the crucial skills and crucial knowledge required for their jobs.

	WORST SECRETARY	BEST SECRETARY
CRUCIAL TASKS		

CRUCIAL
TRAITS

CRUCIAL
SKILLS &
KNOWLEDGE

---

3. If you could find the ideal secretary for your office, what traits, skills, knowledge, and training would she possess?

4. If your current secretary is lacking in terms of any of the three criteria (tasks, traits, skills), what sort of training, if any, do you think would be of value to her?

5. If your secretary does not do the technical or scientific tasks of your office, by what people or referral services are they handled?

6. What tasks would you like to turn over to your secretary if she were qualified to perform them?

7. What additional training or experience would be required before she could perform the tasks mentioned in #6 above?

8. Do you have any on-the-job training program? If yes, please describe.

9. What do you consider to be the minimum educational and training background necessary for a scientific (technical) secretary in your office?

10. Attached is a job description which covers the different types of activities that a scientific secretary would likely perform. Would a person who performed these activities be useful to you if she were available? Please elaborate.

11. Please check on the attached job description form, the specific activities you would like to have your secretary do, and indicate in the spaces next to the relevant category headings, the percent of time she should spend on them.

12. What do you anticipate in the way of changes during the next decade in terms of: (a) office equipment, (b) office procedures, and (c) secretarial functions?

13. Are there any additional comments you would like to make?

Thank you for your help and consideration.

Name and address (optional):

____

____

____

Job Description

Title: Scientific (or Technical) Secretary

Training: Should have college degree, training in secretarial science or equivalent experience, familiarity with scientific method and terminology, and aptitude for administrative-type work. Also must exhibit initiative.

Experience: At least two years of relevant experience.

Duties and Responsibilities: Organizing and analyzing technical and statistical data relative to supervisor's research as required by supervisor; performing all secretarial duties required in supervisor's office.

Please fill in approximate percent of time, and check (✓) the sub-headings that describe what you would like to have your secretary do.

____% 1. Organizing and Analyzing Data

- ____a) Assemble data for supervisor's use in reports, conferences, research projects
- ____b) Read trade publications and other documents, compile summaries of relevant published information, write abstracts of journal articles, prepare annotated bibliographies
- ____c) Summarize supervisor's research reports, write or edit technical reports
- ____d) Attend technical and scientific meetings
- ____e) Make calculations from or prepare graphical representations of technical or statistical data
- ____f) Other (specify)____________________________
- ____g) Other (specify)____________________________

____% 2. General Clerical and Office Management

- ____a) Perform routine administrative duties as required by supervisor

____b) Read and distribute mail to appropriate persons
____c) Supply information to inquirers from own knowledge or from files, either by telephone or by mail; compose routine correspondence
____d) Delegate work to other clerical personnel, and expedite flow of work and materials in the office
____e) Maintain stock of necessary office supplies
____f) Make arrangements for conferences and meetings; arrange appointments for supervisor
____g) Maintain personnel files of people contacted for future placement
____h) Keep records and progress reports on research headed by supervisor; keep supervisor's technical file
____i) Keep correspondence file, data file; review files periodically and recommand material to be moved to storage; maintain pending file
____j) Assist in proofreading of technical and non-technical material
____k) Write or edit non-technical reports
____l) Operate office machines (mimeo, calculator, verifax,etc.)
____m) Other (specify)________________________________
____n) Other (specify)________________________________

____% 3. Typing

____a) Type technical reports, statistical data from rough copy; type scientific and technical terms, formulas and symbols
____b) Type non-technical material
____c) Other (specify)________________________________
____d) Other (specify)________________________________

____% 4. Dictation and Transcription

____a) Take technical dictation and transcribe
____b) Take non-technical dictation and transcribe
____c) Other (specify)________________________________
____d) Other (specify)________________________________

____% 5. Contact with People

____a) Greet visitors, take messages
____b) Attend meetings
____c) Perform duties relative to supervisor's personal business
____d) Exchange information or clarify work details with other members of organization besides supervisor
____e) Other (specify)________________________________
____f) Other (specify)________________________________

____% 6. Data-Processing Equipment

____a) Keypunching
____b) Other (specify)________________________________
____c) Other (specify)________________________________

____% 7. Other (specify)

____a) ________________________________
____b) ________________________________
____c) ________________________________
____d) ________________________________

Note: For purposes of this report, pages of the Questionnaire have been condensed. However, no question has been deleted.

APPENDIX C

Pre-College Math Test

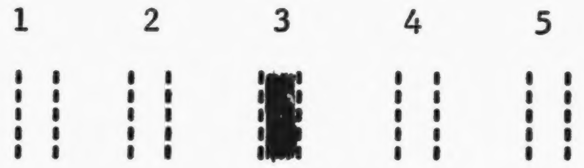
Form A 1966
Robert D. Whetstone

The following page contains fifteen math problems similar to the problems found in a high school math book. When told to begin work, turn the page and work each problem mentally, in the margin of the page, or on the back of the cover page. Record your answers on the separate IBM answer sheet.

Sample Problem	Alternative Answers
2 x ¼ =	(1) 2 (2) ¼ (3) ½ (4) 1/8 (5) 1/16

The correct answer is ½, which is the third alternative answer. Therefore, the area between the dotted lines under the three has been marked below.

Sample Problem Answer



DO NOT TURN THIS PAGE UNTIL TOLD TO DO SO.

1. 13½ x 2 3/4 =
(1) 37 1/8 (2) 35 3/4 (3) 38 3/8
(4) 36½ (5) 36 3/8

2. 8 ÷ 3/4 =
(1) 6 (2) 3/32 (3) 10 2/3
(4) 1/6 (5) 3/4

3. The decimal equivalent of 13 thousandths is:
(1) .13000 (2) .013 (3) .0013
(4) .00013 (5) 13000.

4. The decimal equivalent of 1/9 is:
(1) .11 1/9 (2) 1.11 1/9 (3) 11.11 1/9
(4) .01 1/9 (5) .19

5.
$$\begin{array}{r} 39 \\ .13\overline{)507} \\ \underline{39} \\ 117 \\ \underline{117} \end{array}$$
(1) 3.9 (2) 39.00 (3) 390.
(4) 3900. (5) .39

6. 2% of $4.50 =
(1) .09 (2) .9 (3) 9.
(4) 2.25 (5) 225

7. 12½% of $320 =
(1) 4.00 (2) 40.00 (3) 400
(4) 25.6 (5) 39.9

8. 120% of $80 =
(1) 9.60 (2) 60.0 (3) 66.6
(4) 98.00 (5) 96.00

9. The percent equivalent of 3.3 is:
(1) 33 (2) 3 3/10 (3) 303
(4) 330 (5) .033

10. The decimal equivalent of 3/4% is:
(1) 75 (2) .75 (3) .075
(4) .0075 (5) .00075

11. What percent of $150 is $450?
(1) 33 1/3 (2) .33 1/3 (3) 1/3
(4) 333 (5) 300

12. If the interest rate on a $900 loan was 9% per year, how much cash would one pay at the end of four months?
(1) 270.00 (2) 81.00 (3) 27.00
(4) 36.00 (5) 2.70

13. A new car sold for
$2800.00. After two
years the same car
was worth $1750.00.
How much did it depre-
ciate each year? (1) $575 (2) $525 (3) $1150
(4) $1050 (5) $350

14. If 18% is withheld
from a yearly salary
of $6000.00, how much
is received each month? (1) $1080. (2) $90. (3) $590
(4) $4920. (5) $410.

15. If 9½ gallons contains
76 pints, how many pints
will fill 1/3 of a
gallon? (1) 25 1/3 (2) 26.6 (3) 2 2/3
(4) 3.16 (5) 24

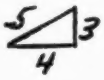
Mathematical Symbols

Directions

The symbols numbered 16 through 48 are arranged in groups of three. The five alternative answers to the right of each group of three symbols contains the term or terms that correctly identifies each of the three symbols. You are to find the correct answer to each symbol and fill in the appropriate space on your answer sheet.

Symbols	Alternative Answers
16. π	1. variance
	2. pi (3.1416)
17. $\sqrt{\ }$	3. right triangle
	4. radical
18. $>$	5. greater than
19. $\equiv$	1. similar
	2. radical
20. $\therefore$	3. identify
	4. inclusion
21. $\sim$	5. therefore

Math. Symbols (contd.)

Symbols	Alternative Answers
22. Σ	1. summation (sigma)
	2. factorial value
23. 	3. absolute value
	4. right triangle
24. $n!$	5. similar triangle

---

25. $\tan \theta$	1. absolute value
	2. integral
26. $\lvert x \rvert$	3. series
	4. slope (trigonometric)
27. $\int$	5. contained in

---

28. $M, \bar{X}, \bar{x} = \sum_{i=1}^{n} \frac{x_i}{n}$	1. increment of a variable
	2. absolute value
29. $x, y \in A$	3. elements of a set
	4. right triangle
30. Δx	5. mean value

---

31. N	1. frequency
	2. number of variables
32. f	3. number of participants
	4. feducial limits
33. X^2, F, t	5. tests of significance

---

34. $S.D., \sigma = \sqrt{\sum_{i=1}^{n} \frac{(x_1 - \bar{x})^2}{n(n-1)}}$	1. contained in (set theory)
	2. union (set theory)
35. $\cup$	3. inclusion (set theory)
	4. standard deviation
36. $\subset$	5. arithmetic mean

---

37. $\in$	1. series
	2. limit
38. $\sum_{i=1}^{\infty} a_1$	3. contained in (set theory)
	4. statistical mean
39. $\lim_{n \to n_0} x_n$	5. union (set theory)

Math. Sumbols (contd.)

Symbols	Alternative Answers
40. $\{a_n\}$	1. series
	2. sequence
41. ∞	3. sine (trig.)
	4. contained in (set theory)
42. sin ϕ	5. infinity

43. $\frac{d}{dx}$	1. differential operator
	2. definite integral
44. $ax^3 + bx^2 + cx + d = 0$	3. transcendental function
	4. general cubic
45. $\int_a^b f(x)\,dx$	5. slope

46. a + bi	1. imaginary number
	2. correlation coefficient
47. f (x) = log x	3. complex number
	4. transcendental function
48. r	5. definite integral

Secretarial Skills Pretest and Post Test

1. Five-minute straight-copy typing.*

2. Five-minute statistical-copy typing.*

3. Ten-minute typing from rough draft with proofreading for unmarked errors.**

4. Shorthand dictation and transcription.

---

*Achievement Test 2, Page 1. College Typewriting, Seventh Edition by Lessenberry, Wanous, and Duncan, South-Western Publishing Co., Chicago, Illinois, 1965.

**Secretary's Day in the Office of W. A. Sheaffer Pen Company, Page 6. (Tests prepared and published with cooperation of the Foundation for Business Education), W. A. Sheaffer Pen Company, Fort Madison, Iowa, (no date of publication).

Test Instructions

1. Check to see that you have been given these supplies:

   Shorthand notebook
   Eraser
   5-minute straight-copy timed writing copy; statistical typing
   Proofreading and rough draft copy
   Six sheets of white paper

2. There will be four parts to this test. Relax, and don't worry if any part of the test is difficult for you. We need to find out what you know so that we can adjust our course work as much as possible to fit your needs. These tests will guide us.

3. Now, spend a few minutes getting acquainted with your machine. Use one sheet of your white paper to practice - there is a drill book by your machine. Do not use test material for this purpose.

Test

1. 5-minute straight-copy timed writing. Set your machines for a 70-space line and double spacing. No erasing.

2. 5-minute statistical-copy timed writing. Again, use a 70-space line and double spacing. No erasing.

3. Proofreading and rough draft typing. You will erase. Note that this is proofreading as well as typing from rough draft. Some errors have not been marked. Both speed and accuracy are important. You will have 10 minutes. I'll warn you when you have only 30 seconds left so that you can check for any typing errors.

   Relax for a few minutes before shorthand dictation and transcription.

4. Shorthand dictation and transcription. I'll dictate for three minutes at three different speeds - 70, 90, 110. After I finish the dictation, you will have 15 minutes to read your notes and transcribe as much as you can. Correct your typing errors. If you get the dictation at 110, transcribe that first; if you have time go to the dictation at 90. If you can't transcribe the dictation at 110, start transcribing the dictation at 90;

then if you have time, continue to the 70 wpm. If you don't get the two higher speeds, transcribe as much as you can from the 70 wpm. Continue until I call time. We'll check your work for speed of dictation transcribed, speed of transcription, and percentage of accuracy.

Note: The same instructions should be used when this material is used for the post test.

Shorthand and Transcription (30 minutes)

Dictation at three speeds for three minutes at each speed. Transcription for 15 minutes from highest speed possible.

Dictation material taken with permission from NCAR Quarterly, Winter 1965-66.

70 words per minute

Sacramento Peak Observatory, a United | States Air Force installation located on an | isolated mountaintop in southern New Mexico |, is one of the world's most advanced centers for solar | studies. This observatory carries on research of | great practical importance to the Air Force, and is also | making highly significant contributions to our | knowldge of the complex physical processes of the sun. | (1)

The observatory was founded after World War II | when it became evident that solar activity | such as flares, prominences, and coronal emissions | had important effects on the earth's higher atmosphere | and on the near-space environment beyond it. | Future Air Force missions were likely to operate in | those areas, and detailed knowledge of the solar effects | (2) to be encountered could be vitally important. |

This Air Force interest coincided with the fact that | astronomers on the staff of the High Altitude | Observatory at Climax and Boulder, Colorado | felt the need for an alternate site that could secure | observations of the sun during periods when the | Climax station was closed by weather. It appeared that such | (3) a site could be an excellent base for a program of solar research to be sponsored by the Air Force.

90 words per minute

When this was decided, the Air Force turned to Harvard College Observatory and to HAO for advice and help in setting up the new observatory. In August 1947 they selected the summit of Sacramento Peak as the most promising site of the region. HAO sent a team of observers to camp out on the Peak to begin test observations of sky clarity - hour-by-hour, day-by-day, month-by-month. These showed that the site, at an elevation of (1) 9200 feet, offered exceptionally favorable observing conditions for solar coronal research, one of the most demanding of astronomical studies.

During the next few years the Peak acquired the western hemisphere's second solar coronagraph as well as permanent living quarters and buildings to house scientific equipment and shops. Later, as a regular observing program took shape, Sacramento Peak acquired a paved road to the outside (2) world, and other necessities such as an emergency helicopter pad, modern utilities, telephone and radio communications and a fire department. Today, 70 people work at Sac Peak and 140 people live there.

Harvard College Observatory and the High Altitude Observatory have cooperated in support of the Sacramento Peak Observatory from the beginning days, and continue their association today. (3)

110 words per minute

The High Altitude Observatory has a scientific staff of 15 on Sacramento Peak - participating in the observing programs, the instrumental development programs, and the research itself. Moreover, the two observatories conduct an annual joint research meeting at Santa Fe, where the staffs informally exchange findings, debate solar physical problems, and cooperatively plot their strategies of attack on solar unknowns.

The Sacramento Peak Observatory conducts a dual program to achieve two different sorts of objectives: a routine solar patrol secures (1) long-term basic records of solar activity, and a program of short-term specialized observations provides data for specific research projects.

A survey of these programs, and particularly of the technology necessary to support and advance them, gives a good idea of what is required to mount a "broad approach" to solar research.

The patrol observations at Sac Peak, begun in 1948, are conducted by a team of eight Harvard College Observatory staff members operating under an Air Force contract. The three principal patrol (2) instruments at Sac Peak monitor the three major regions of the sun - sunspots in the photosphere, flares and prominances in the chromosphere, and the activity of the corona. Patrol films are developed and reviewed daily, and only the footage which records events of research value is kept. These patrol films, archived in a fireproof vault for future use, are a major research asset for Sac Peak.

The essential patrol data on solar activity are telephoned to the World Data Center for solar activity at HAO in Boulder. Word of any unusual solar activity is telephoned(3) at once to the Data Center, so that other research centers can be alerted.

Scientific Secretary Training Program

Science Test

1. Kaolin
   a. is a medieval Chinese scientist.
   b. is a small animal native to Australia.
   c. is the residue formed in nuclear reactors.
   d. is a mineral found in clay.
   e. is the layer of wood just beneath the bark of a tree.

2. W. L. Bragg
   a. discovered the ultra-violet spectrum.
   b. used X-rays to investigate crystal structure.
   c. investigated photo-oxidation in the early nineteenth century.
   d. invented the cyclo-synchrotron.
   e. synthesized the first artificial protein.

3. Alpha particles
   a. are emitted by certain radioactive materials.
   b. were the first elementary particles to be discovered.
   c. are a part of the nucleus of hydrogen.
   d. is another name for protons.
   e. have a negative electrical charge.

4. Electron shell
   a. is the resistant outer layer of an electron.
   b. is a relatively stable group of electrons in an atom.
   c. is the outer layer of the Van Allen belt.
   d. is the positively-charged layer of an atom.
   e. is what remains after an electron is neutralized.

5. The atomic nucleus
   a. is the central group of atoms in a large molecule.
   b. was discovered by Mendeleev.
   c. is composed of electrons.
   d. is less massive than the atomic electrons.
   e. is always positively charged.

6. We cannot know exactly both the location and the speed of a particle. This is a manifestation of, or is due to
   a. the inaccuracy of our present instruments.
   b. Rutherford's scattering experiments.
   c. the inadequacy of our mathematical techniques.
   d. Maxwell's equations.
   e. the uncertainty principle.

7. The isotopes of an element
   a. are always radioactive.
   b. have the same number of nuclear protons.
   c. are more dense than the non-isotopic atoms.
   d. have the same number of nuclear neutrons.
   e. must be electrically charged.

8. In "pair production" or "pair formation"
   a. a molecule is broken down into two atoms.
   b. both particles produced have the same electrical charge.
   c. an identical pair of nucleons is produced.
   d. the particles are formed from the energy of gamma-radiation.
   e. the process cannot take place near an atomic nucleus.

9. Cosmic ray showers
   a. generally accompany heavy spring rains.
   b. are produced by incoming high-energy particles.
   c. are composed primarily of helium nuclei.
   d. were first observed by the ancient Greeks.
   e. are composed of electrically neutral particles.

10. The beta-particles emitted in beta-decay are
   a. ordinary electrons.
   b. protons.
   c. neutrinos.
   d. equivalent to two alpha-particles.
   e. without any observable electric charge.

11. The inventor of the "cloud chamber" was
   a. Rutherford.
   b. Edison.
   c. Cavendish.
   d. Wilson.
   e. Thomson.

12. The diameter of an atom is about __________ times as large as the diameter of the atom's nucleus.
   a. 10
   b. 100
   c. 1,000
   d. 10,000
   e. 100,000

13. The fissionable element plutonium is produced from
   a. Uranium - 235.
   b. Uranium - 238.
   c. radioactive lead.
   d. the oxidation of other radioactive materials.
   e. Thorium.

14. The semi-transparent jelly-like material of which most living cells are largely composed is
    a. chromatin.
    b. luciferinase.
    c. protoplasm.
    d. the cellular nucleus.
    e. the cellular membrane.

15. Mitosis
    a. is a virus disease of certain plants.
    b. is the process of cell division.
    c. is an abnormal chromosome.
    d. was the Greek city in which Aristotle lived.
    e. is a species of fruit-fly.

16. The difference between man and woman arises from the difference in their sex chromosomes:
    a. Man has X ; woman has Y.
    b. Man has Y-Y ; woman has X-X.
    c. Man has none; woman has X or Y.
    d. Man has Y ; woman has X.
    e. Man has X-Y ; woman has X-X.

17. If pure red four-o'clocks (two "red" chromosomes) are crossed with pure white four-o'clocks (two "white" chromosomes), all the progeny will be pink (one "white" and one "red" chromosome). If two of these pink flowers are crossed, they will produce
    a. all pink flowers.
    b. all red flowers.
    c. all white flowers.
    d. ½ white, ½ red flowers.
    e. ¼white, ½ pink, ¼ red flowers.

18. "Mutations"
    a. are defects caused by excessive in-breeding.
    b. are caused by changed in the chemical structure of genes.
    c. prevent the normal progress of evolution.
    d. are fatal if inherited by the next generation.
    e. are the Mendelian inheritance of recessive alleles.

19. The diameter of the moon is about
    a. 500 miles.
    b. 1,000 miles.
    c. 2,000 miles.
    d. 5,000 miles.
    e. more than 6,000 miles.

20. The Milky Way
   a. is composed of clouds of luminous gas at enormous distances.
   b. is a belt of luminous gas within the Solar System.
   c. is a zone of dust particles illuminated by the Sun.
   d. is composed of stars too distant to be seen individually.
   e. provides the material from which comets are formed.

21. The most astronomically useful characteristic of the Cepheid variables is that
   a. their absolute brightness is related to their period of light fluctuation.
   b. they are all found in the Andromeda Nebula.
   c. they are all of very nearly the same brightness.
   d. they are all receding from the earth at nearly the same speed.
   e. their colors are related to their distances from the earth.

22. The most plentiful chemical element in the universe is
   a. oxygen.
   b. iron.
   c. helium.
   d. hydrogen.
   e. calcium.

23. The energy source of the Sun and most other stars is
   a. the release of gravitational potential energy.
   b. the decay of radioactive elements.
   c. the nuclear fission of uranium and other heavy elements.
   d. the production of helium from hydrogen.
   e. the oxidation of carbon.

24. The "red shift" observed in distant galaxies is interpreted to mean that
   a. light is reddened by the intervening gas.
   b. the universe is expanding.
   c. light used to be redder than it now is.
   d. distant galaxies are approaching us at high speed.
   e. distant galaxies are made from different materials than our Solar System.

25. In its younger days, Earth's atmosphere probably
   a. contained much ammonia and methane.
   b. was much thinner than it is today.
   c. contained more oxygen than it does now.
   d. was principally chlorine and fluorine.
   e. was nearly opaque.

26. The oxygen in the earth's atmosphere was probable produced by
 a. meteorites.
 b. the decomposition of methane.
 c. volcanic eruptions.
 d. the action of plants.
 e. solar radiation.

27. The discovery of oxygen as a chemical element was made by
 a. Lavoisier.
 b. Dalton.
 c. Priestley.
 d. Avogadro.
 e. Franklin.

28. The "benzene ring" is made up of
 a. chelated metalloids.
 b. 6 atoms of carbon.
 c. alternating atoms of carbon and oxygen.
 d. carbon with a valence of two.
 e. a circle of gasoline molecules.

29. The positively charged "particles" in an atomic nucleus are
 a. positrons.
 b. neutrinos.
 c. electrons.
 d. protons.
 e. neutrons.

30. The lightest and simplest of the chemical elements is
 a. helium.
 b. oxygen.
 c. deuterium.
 d. lithium.
 e. hydrogen.

31. Atoms are bonded together to form molecules by
 a. the mutual attraction of their nuclei.
 b. the interpenetration of their inner electron shells.
 c. the interaction of their outer electrons.
 d. intense gravitational forces.
 e. the selective repulsion of similar valences.

32. An important chemical element, almost inert at ordinary temperatures, approximately between the metals and the non-metals in the periodic table, with a melting point higher than 6,000° F is

a. hydrogen.
b. iron.
c. chlorine.
d. carbon.
e. nitrogen.

33. Generally speaking, a catalyst
   a. makes a chemical reaction proceed faster than it otherwise would.
   b. is one of a series of ring compounds containing nitrogen.
   c. is one of several ores from which catalium is obtained.
   d. is dangerously inflammable.
   e. cannot be stored, hence must be made as it is used.

34. The principal industrial source of chlorine is
   a. limestone.
   b. salt.
   c. coal.
   d. natural gas.
   e. sugar-cane fermentation.

35. Thermoplastics
   a. may substitute for mercury in thermometers.
   b. are widely used as heat insulators.
   c. become soft when they are heated.
   d. are made from thermite and alcohol.
   e. were invented by L. H. Baekeland.

36. A characteristic that nylon, cellulose, and silicone rubber have in common is that
   a. they were all invented by DuPont.
   b. they are all made from coal-tar distillates.
   c. they are all polymers.
   d. they all contain substantial amounts of nitrogen.
   e. they all become brittle at high temperatures.

37. Which of the following is not a crystalline substance?
   a. ice
   b. glass
   c. gold
   d. steel
   e. rutile

38. Phosphors
   a. can convert other forms of energy into visible light.
   b. are chelated compounds of activated phosphorus.
   c. are the chemical compounds used in match-heads.

d. were invented and first developed by Edison.
e. work most efficiently at very high temperatures.

39. The term "holes" applied to semiconductors refers to
a. zones in which the Stork effect does not operate.
b. electrons missing from the crystal structure.
c. perforations made to help ventilation.
d. invisible cracks between the crystal boundaries.
e. impure zones that will not conduct current.

40. Photosynthesis
a. converts electromagnetic radiant energy into chemical energy.
b. is the fundamental chemical reaction in photography.
c. is the combination of a mosic of smaller photographs.
d. refers to the biological applications of photo-micrography.
e. refers to high-speed photography of chemical reactions.

41. The shift from the geocentric theory to the heliocentric theory of the Solar System is generally attributed to
a. Ptolemy.
b. Galileo.
c. Aristotle.
d. Copernicus.
e. Kepler.

42. In which of the following are the planets mentioned correctly listed in the order of their increasing distance from the sun?
a. Venus, Earth, Jupiter
b. Mars, Mercury, Saturn
c. Jupiter, Mars, Earth
d. Mars, Venus, Pluto
e. Saturn, Venus, Mars

43. The first man to do published astronomical work with the telescope was
a. Archimedes.
b. Kepler.
c. Copernicus.
d. Newton.
e. Galileo.

44. The orbit of any planet around the Sun is very nearly
a. a parabola.
b. an ellipse.
c. a circle.
d. a hyperbolic paraboloid.
e. a geoid.

45. The inverse-square law of gravity was proposed by
    a. Galileo.
    b. Einstein.
    c. Aristotle.
    d. Kepler.
    e. Newton.

46. A geological revolution is
    a. the rotation of a rock formation due to earthquake activity.
    b. a sudden change in the course of a stream or river.
    c. an extended period of mountain building.
    d. the reversal of direction of flow of a river.
    e. marked by the sudden appearance of new fossil species.

47. Which of the following lists the geological eras in their proper chronological order?
    a. Paleozoic, Mesozoic, Cenozoic
    b. Mesozoic, Cenozoic, Paleozoic
    c. Cenozoic, Paleozoic, Mesozoic
    d. Paleozoic, Cenozoic, Mesozoic
    e. Cenozoic, Mesozoic, Paleozoic

48. A bathyscaph is
    a. an extinct pre-Cambrian mollusk.
    b. a vehicle for descending into the ocean deeps.
    c. a deep mountain lake fed by glacial melting.
    d. the edge of the continental shelf.
    e. a sharp break in elevation caused by faulting.

49. Magnetic declination is
    a. the angle between true north and the direction indicated by a compass needle.
    b. a gradual diminution in the strength of the earth's magnetic field.
    c. the downward tip of a freely-suspended compass needle.
    d. the sudden diminution of field strength casued by a magnetic storm.
    e. the natural gradual decrease in strength of a compass needle.

50. Observations of ocean tides indicate that
    a. the Sun has more effect on the tides than the Moon.
    b. tides are highest when the moon is new or full.
    c. neap tides are generally higher than spring tides.
    d. high tides average exactly 12 hours apart.
    e. they are caused primarily by daily shifts in wind direction.

51. The two principal constituents of air are approximately
   a. ½ oxygen; ½ hydrogen.
   b. 4/5 oxygen; 1/5 carbon dioxide.
   c. 1/5 nitrogen; 4/5 oxygen.
   d. 4/5 oxygen; 1/5 ozone.
   e. 4/5 nitrogen; 1/5 oxygen.

52. The tropopause
   a. is the boundary between the troposphere and the ionosphere.
   b. is the period of stillness preceding a change in the direction of the wind.
   c. refers to the still air lying over the tropics.
   d. is the boundary between the troposphere and the stratosphere.
   e. has an average altitude of between 1 and 2 miles.

53. Cyclones in the northern and southern hemispheres rotate
   a. unpredictably either clockwise or counter-clockwise.
   b. clockwise and counter-clockwise, respectively.
   c. counter-clockwise and clockwise, respectively.
   d. both clockwise.
   e. both counter-clockwise.

54. Normally, most cyclones are formed
   a. to the east of mountain ranges.
   b. near the tropopause.
   c. from extreme thunderstorm activity.
   d. along the polar front.
   e. in Kansas.

55. The Van Allen belts are formed primarily
   a. above the courses of severe thunderstorms.
   b. of gamma-radiation.
   c. of electrons and protons.
   d. from the debris of ancient earth satellites.
   e. at the lower boundary of the ionosphere.

56. Entropy is concerned with
   a. the First Law of Thermodynamics.
   b. the Second Law of Thermodynamics.
   c. the nutritional requirements of bacteria.
   d. Maxwell's Laws.
   e. Copernicus' theory of the Solar System.

57. In any irreversible process
   a. some energy vanishes.
   b. the average energy of the molecules decreases.
   c. the entropy of the system increases.

d. energy is converted into momentum.
e. the temperature of the system increases.

58. A spinning ice-skater with arms outstretched speeds up when he draws his arms in close to his body. This is an example of
a. degradation of energy.
b. a decrease in entropy.
c. the application of deMoivre's theorem.
d. conservation of angular momentum.
e. energy conversion through friction.

59. Start with one gram of a radioactive substance with a half-life of two years. At the end of six years, you will have left
a. 1/3 gram.
b. 2/3 gram.
c. 1/8 gram.
d. none
e. You do not have enough data given to answer the question.

60. If life had never existed on the earth, which rock would now be almost entirely missing?
a. granite
b. limestone
c. sandstone
d. biotite
e. gneiss

61. The "escape velocity" from the earth is
a. greater for a large satellite than for a molecule.
b. about 17,000 miles per second.
c. greater than the escape velocity from the moon.
d. greater than the escape velocity from Jupiter.
e. strongly dependent on the temperature.

62. The theory of "spontaneous generation" was practically eliminated by the experiments of
a. Lord Lister.
b. Buffon.
c. Galileo.
d. Pasteur.
e. Newton.

63. The first "organic" compound to be synthesized from inorganic materials was
a. cellulose.
b. nucleic acid.

c. indigo.
d. creatine.
e. urea.

64. First life on the earch probably originated
a. in the Paleozoic era.
b. in the tropical region of Africa.
c. in the ocean.
d. in a region of high volcanic activity.
e. in the upper atmosphere.

65. The complexity and variation of organic compounds is largely dependent on the characteristics of atoms of
a. nitrogen.
b. carbon.
c. phosphorus.
d. oxygen.
e. hydrogen.

66. Molecules having the same atomic formula, but in which the atoms are arranged differently, are
a. isotopes.
b. valences.
c. substituted compounds.
d. allotropes.
e. isomers.

67. Two polymers of glucose are
a. fatty acids and carbohydrates.
b. aldehydes and pyridenes.
c. starch and cellulose.
d. glycogen and protein.
e. polystyrene and globulin.

68. The polymerization of amino acids to form proteins is controlled by the action of
a. fermentation.
b. enzymes.
c. DNA.
d. hydrolysates.
e. carbon dioxide.

69. $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ is the basic equation of
a. cellular digestion.
b. fermentation.
c. protein synthesis.
d. photosynthesis.
e. hydrolysis.

70. The difference between electrical conductors and insulators lies in
   a. the ability of atoms of the conductor to easily exchange electrons with their neighbors.
   b. the smaller electric charge of the electrons in insulators.
   c. the presence of strongly-charged carbon nuclei in insulators.
   d. the inability of an electric field to affect the electrons in atoms of a conductor.
   e. the formation of standing waves by the conductor electrons.

71. The attraction and repulsion of electric charges was first quantitatively investigated by
   a. Benjamin Franklin.
   b. Charles Coulomb.
   c. Andre Ampere.
   d. Hans Oersted.
   e. Isaac Newton.

72. In an ordinary wire carrying an ordinary electric current, the average velocity of the electrons is about
   a. a fraction of a millimeter per second.
   b. a few feet per second.
   c. the same as the speed of sound.
   d. a few miles per second.
   e. 186,000 miles per second (the speed of light).

73. The "Doppler Shift" is the basis for
   a. the operation of transformers.
   b. tuning radio and television receivers.
   c. high-fidelity and stereophonic sound reproduction.
   d. radar automobile speed traps.
   e. the separation of the colors in color TV.

74. "Magnetic bottles"
   a. are normally made from soft iron.
   b. have been used in nuclear fusion experiments.
   c. are useful accessories for accurate compasses.
   d. have been used for collecting interplanetary dust.
   e. are devices used in radio broadcasting.

75. Infrared detection devices
   a. operate on wavelengths longer than radar.
   b. are highly sensitive to ultraviolet.
   c. are used in cardiac pacemakers.
   d. are used in tracking missiles.
   e. operate on wavelengths shorter than visible light.

76. The three-electrode vacuum tube was invented and developed by
    a. Edison and Marconi.
    b. deForest and Armstrong.
    c. Armstrong and Marconi.
    d. Fleming and Edison.
    e. deForest and Fleming.

77. Superconductivity
    a. can be displayed only by special alloys of copper.
    b. was first discovered in the United States.
    c. refers to surface effects observed on insulators.
    d. takes place only at very low temperatures.
    e. depends largely on high magnetic fields.

78. Tuning a radio consists of adjusting the frequency of a resonant circuit containing primarily
    a. resistance and magnetism.
    b. capacitance and an inductance coil.
    c. an inductance coil and resistance.
    d. an adjustable magnetic field.
    e. inertia and inductance.

79. The ionosphere
    a. is the outermost layer of electrons in an atom.
    b. is the weatherproof shielding around arctic radar stations.
    c. consists primarily of gamma-radiation.
    d. is a region in the upper atmosphere containing free electrons.
    e. is transparent to long-wave radio signals.

80. An alpha-particle is
    a. an electron pair.
    b. an electrically charged hydrogen atom.
    c. has a negative electric charge.
    d. a highly penetrating form of radiation.
    e. the nucleus of a helium atom.

81. Jodrell Bank
    a. is one of the repositories for the World Monetary Fund.
    b. is the source of many fossils of prehistoric man.
    c. is the location of one of the largest radio telescopes.
    d. was installed to monitor communications satellites.
    e. is invisible except to special ultra-violet detectors.

82. The energy of particles accelerated in an ordinary cyclotron is limited because of

a. the relativistic increase of the particles' mass at high speeds.
b. decomposition of the particles at high energies.
c. over-saturation of the cyclotron's magnetic field.
d. penetration of the shielding by the high-energy particles.
e. interaction between the particles and the high-frequency field.

83. X-rays
a. consist of high-speed electrically-charged particles.
b. are similar to light but of shorter wavelength.
c. can be deflected by a magnetic field.
d. are also known by the name "cathode rays."
e. like light, can be focused by ordinary lenses.

84. Pure water
a. is a relatively good conductor of electricity.
b. is highly ionized at ordinary room temperature.
c. is an extremely poor conductor of electricity.
d. contracts when it freezes into ice.
e. is a strongly non-polar substance.

85. The logical argument known as the "syllogism" was first analyzed by
a. Vitruvius.
b. Aristotle.
c. Plato.
d. Poe.
e. Descartes.

86. Punch-cards very similar to the modern "IBM cards" were used early in the 19th century on
a. a popular children's game.
b. a control device for steam engines.
c. accounting in the Bank of England.
d. the Jacquard loom.
e. military logistics in the Napoleonic wars.

87. An algebraic, symbolic algebra for dealing with the processes of logic was worked out by
a. Dodgson.
b. Venn.
c. Babbage.
d. Cortondis.
e. Boole.

88. A "nanosecond" is a
    a. time unit of variable length.
    b. thousandth of a second.
    c. millionth of a second.
    d. billionth of a second.
    e. trillionth of a second.

89. Ferrite cores are part of some computers'
    a. print-out mechanism.
    b. memory.
    c. input switching devices.
    d. programming equipment.
    e. analog equipment.

90. A sliderule is a simple kind of
    a. binary converter.
    b. distance measuring device.
    c. digital computer.
    d. analog computer.
    e. difference engine.

91. A high degree of numerical accuracy is characteristic of
    a. differential analyzers.
    b. analog, rather than digital, computers.
    c. digital, rather than analog, computers.
    d. all modern calculators.
    e. random access memories.

92. In binary code, "101" represents the same number that we ordinarily refer to as
    a. one hundred and one.
    b. fifty-five.
    c. nine.
    d. seven.
    e. five.

93. The number "six" (in our ordinary language) would be designated in the binary code as
    a. 111111.
    b. 111.
    c. 1010.
    d. 110.
    e. 101.

94. 2½ could be represented in binary code as
    a. 010.
    b. 10.1.
    c. 1.01.
    d. 001.
    e. Fractions cannot be represented in binary code.

95. The abacus is
    a. a form of digital computer.
    b. a form of analog computer.
    c. a kind of binary converter.
    d. a primitive differential analyzer.
    e. a modified kind of "truth table."

96. "Alpha rhythm" is a phrase relating to
    a. preparing computer programs.
    b. the passage of electrical current into a computer memory.
    c. the extraction of information from the computer memory.
    d. electrical pulses originating in the brain.
    e. the printing of the results of a computer program.

97. A name prominent in modern computer design was
    a. Capek.
    b. von Neumann.
    c. Cortondis.
    d. Boole.
    e. Chandrasekhar.

98. The basic parts of a computer are
    a. input, storage, control, arithmetic, output.
    b. card-punch, memory, control, programming.
    c. recorder, programmer, memory, output, printer.
    d. arithmetic, analyzer, output, memory.
    e. memory, storage, arithmetic, analyzer.

99. 0100 is ________ times as large as 0001 (in binary code)?
    a. one hundred
    b. two
    c. one-half
    d. four
    e. fifty

100. LaPlace, Kant, Chamberlin, and Moulton all proposed hypotheses concerning
    a. the origin of the Solar System.
    b. the application of radioactive dating.
    c. the cause of earthquakes.
    d. the chemical composition of the earth's early atmosphere.
    e. the origin of life.

APPENDIX D

Form for Instructor's Rating of Trainees

Name	Class	Group

Attendance Record (No. absences)

In-class Test Scores

Anecdotal Information of an Evaluative Nature

Name Class

Ratings: Please check the appropriate category on each of the rating scales below:

1. Degree of trainee's improvement over the year.

1	2	3	4	5
very poor	below average	average	above average	out-standing

2. Trainee's final level of achievement.

1	2	3	4	5
very poor	below average	average	above average	out-standing

3. Degree of interest shown by trainee.

1	2	3	4	5
very poor	below average	average	above average	out-standing

4. What kind of impression does she make?

1	2	3	4	5
very poor	below average	average	above average	out-standing

5. Overall rating of trainee as a scientific secretary, as compared with the rest of the class.

1	2	3
top third	middle third	bottom third

APPENDIX E

Pilot Project Evaluation

The following questions represent concerns of the project staff. Place your marks in the appropriate columns to the right. Your written comments will be greatly appreciated.

I. General Evaluation: Place an E (Excellent), S (Satisfactory), or U (Unsatisfactory) for each question under each of the four areas of instruction (Secretarial Skills, Science, Math and English).

A. In terms of your conception of a scientific secretary's work, please rate the relevance of the four areas of instruction.

B. How would you rate your own degree of improvement in the knowledge and skills covered by each area?

C. Rate the degree to which your previously acquired skills or knowledge prepared you for work in each area.

Skills	Sci.	Math	Eng.

D. Please explain further all U (Unsatisfactory) ratings given in Part I above.

II. Specific Evaluation: As above, please rate the following questions, using E, S, or U for each of the four areas.

A. Is the instruction presented at an understandable level?

B. Are the instructional materials appropriate for the students in the course?

C. Does the method of instruction seem effective for efficient learning of the content?

Skills	Sci.	Math	Eng.

D. Is the content relevant to the work of a scientific secretary, as you understand the job?

E. Has enough time been scheduled for each area?

F. Is the class interesting and/or stimulating?

G. Is the amount and difficulty of the homework assignments reasonable?

H. Is the amount and difficulty of in-class work reasonable?

I. How would you rate the frequency of tests given?

Skills	Sci.	Math	Eng.

J. Please explain all U (Unsatisfactory) ratings given in Part II, and indicate any suggestions you might have for improving these aspects of the Program.

III. 1. What phase or phases of the Program do you consider most worthwhile?

2. What do you consider of little importance?

APPENDIX F

Confidential Questionnaire for Supervisors or Employers of Trainees in the Scientific Secretary Training Program

March 15, 1967

As you probably know, ______________________________ has participated in a scientific secretary training program since September, 1966. We are now evaluating the first phase of the program and would appreciate very much your cooperation in supplying the following information. Any comment that you make is strictly confidential. Your judgments will be most beneficial to us, not only in evaluating the various aspects of our program, but also in providing motivation and encouragement to the trainees.

Please use the time period of September 27, 1966 (the beginning of the program) till the present date as your frame of reference for statements related to the training program.

1. Trainee's present title ______________________________

2. Please give a brief description of trainee's current work responsibilities.

   ____

   ____

   ____

3. Brief work history of the trainee in your organization, including dates of employment and promotions.

   ____

   ____

   ____

4. As a result of the trainee's participation in this project, what new responsibilities or assignments has she received other than promotions?

   ____

   ____

   ____

5. Has the trainee received any salary increase or other benefits as a result of this training program?

No	Yes	
________	________	If yes, what?

____

____

____

6. Have you noted any changes in the trainee while she has been in the program (since September 27, 1966). If you check yes, describe briefly.

No	Yes	
		(a) Secretarial skills
_____	_____	Typing______________________
_____	_____	Shorthand______________________
_____	_____	Transcription______________________
_____	_____	Other______________________
		(b) Knowledge
_____	_____	Science______________________
_____	_____	Math______________________
_____	_____	English______________________
_____	_____	Other______________________
_____	_____	(c) Interest______________________
_____	_____	(d) Attitude______________________
_____	_____	(e) Overall performance______________________

7. Do you have other secretaries in your organization who could benefit from and should attend a program such as the Scientific Secretary Training Program? If so, how many? ________

8. Do you have any recommendations for improving the Scientific Secretary Training Program?

____

____

____

____

9. Do you know of employment opportunities for additional secretaries trained in this program? If so, please specify.

____

____

____

Thank you very much for your cooperation. We plan to use another evaluation questionnaire around November, 1967, to evaluate the progress of the trainees.

APPENDIX G

Most Frequently Mentioned Responses: Total Questionnaire and Interview Data

I. Secretary

A. Preliminary Run N = 68
B. Final Run N = 96
C. After Cut-off N = 34
Total N = 198

1. Biographical Data:

Principal Product:	A	B	C	ABC
Research	9	18	4	31
Chemical	3	7	2	12
Electrical Product	4	2	5	11
Electrical Apparatus	5	4	1	10
Missiles	2	3	5	10
R & D	4	3	1	8
Field:				
Aerospace	6	10	7	23
Physics	6	12	3	21
Research	8	4	6	18
Chemistry	4	9	2	15
Electronics	7	3	5	15
Engineering	7	2	1	10
Type of Organization:				
Industry	43	60	18	121
Government	21	13	7	41
Govt. & Ind.	9	11	3	23
Education	7	9	2	18
Type of Research:				
Applied	37	33	11	81
Basic	9	11	4	24
Both	24	37	10	71

Total No. of Employees Mode:

100;3,000 6 10,000: 15 10,000: 9

	A	B	C	ABC
No. Secretaries, Dept. Mode:				
	one: 4	one: 21	two: 8	
Secretary's Title Mode:				
Secretary:	22	44	15	
No. Years on the Job Mode:				
	one:year: 11	24	6	
GS Rating:				
No	54	72	21	147
Yes	8	11	8	27
GS No. Mode:	4: 3	4: 4	5: 3	
Steno Pool:				
No	62	90	34	186
Yes	5	1	0	6
No. Secretaries in the Office Mode:				
	4: 3	4 = 4	5 = 3	
Age Mode:	40: 22	40: 33	39: 11	
Marital Status Mode:				
Married	44	56	20	120
Single	24	40	14	78
Occupation of Spouse:				
Student:	6	5	1	12
Engineer:	4	5	3	12
Education of Spouse Mode:				
High School	13	H.S.: 18	1 yr: 5	

	A	B	C	ABC
Supervisor's Title Mode:				
	Director, Div. or Prog. 14	Mgr., Div. or Dept. 22	Dir., Div. or Prog. 8	
Percent of Supervisor's Time Mode:				
	% N	% % % N	% N	
Administration:	100: 18	100: 33	100: 8	
In research lab:	50: 10	5,10,50: 6	10: 3	
Teaching:	10: 3	10,20: 3	5: 2	
No. Previous Jobs Mode:				
	4: 22	2: 21	4: 7	
No. Technical Secretary Jobs Mode:				
	1: 12	3: 20	1: 3	
Area of Emphasis in High School Mode:				
	liberal arts: 19	bus: 88	bus: 13	
No. of College Graduates:				
	10	8	2	

2. Secretary Questionnaire and Interview Questions:

Most helpful courses:	A	B	C	ABC
Typing	35	69	19	123
Shorthand	31	50	16	97
English	29	36	17	82
Secretarial	12	8	7	27
Chemistry	4	2	4	10

What other courses do you wish you had taken?

Chemistry	11	21	2	34
Math	11	13	3	27
Foreign Language	9	9	4	22
Physics	5	13	3	21
General Science	4	10	4	17
Advanced Math	1	8	3	12
English	3	6	3	12
Shorthand	3	5	3	11

	A	B	C	ABC
Math and Science courses taken:				
Algebra	30	43	20	93
Geometry	18	25	15	58
Biology	14	31	12	57
General Science	9	29	7	45
General Math	9	23	6	38
Chemistry	16	11	9	36
Physics	13	12	3	28
Did you enjoy these science and math courses?				
Yes	-*	57	19	76
No	-*	16	4	20
How obtained present position:				
Promotion	31	48	16	95
Referral	6	12	4	22
Employment agency	7	9	4	20
Newspaper ad	9	7	2	18
School Placement Office	4	7	1	12
Why applied for this job:				
Work interesting, challenging	8	14	9	31
Advancement	10	11	5	26
Interest in science and research	6	11	4	21
Job offered; did not apply	6	11	4	21
Salary	9	10	2	21
Experience	3	8	2	13
Interest in technical work	3	7	2	12
Convenient	0	10	2	12
Crucial Tasks:				
Fast and accurate typing, shorthand	17	35	6	58
Technical typing	13	23	7	43
Telephone duties	10	9	9	28
Run office smoothly	13	10	4	27
Filing	8	4	6	18

*Question not asked in preliminary run.

	A	B	C	ABC
Crucial Traits:				
Getting along with people	13	39	19	71
Tact, poise	13	21	10	44
Trustworthy, loyal	12	19	10	41
Patience, disposition	15	14	8	37
Intelligence	12	9	9	30
Initiative	3	16	11	30
Cooperative	8	14	6	28
Efficiency	11	14	3	28
Accuracy	14	12	1	27
Responsible	13	11	0	24
Crucial Skills:				
Typing	6	59	15	80
English	13	39	13	65
Shorthand	4	44	11	59
Basic secretarial	11	10	4	25
Understanding job requirements	4	15	6	25
Scientific terminology	8	15	2	25
Change to be "ideal:"				
More technical knowledge	9	9	3	21
More science	5	8	4	17
Better typing	4	7	4	15
Better technical vocabulary	2	8	3	13
Unique tasks of the Scientific Secretary:				
Technical typing	26	34	8	68
Use of technical terminology	11	16	5	32
Technical dictation and transcription	4	12	7	23
Handling classified materials	6	9	5	20
Would specialized training have been of value before taking job?				BC
Yes	-*	75	26	101
No	-*	15	6	21

	A	B	C	BC
Would specialized training be of value now?				
Yes	-*	59	18	77
No	-*	27	13	40
What advantages would a SSTP have given you?				
Scientific terminology	-*	37	15	52
Wouldn't have to learn the hard way	-*	14	2	16
Scientific understanding	-*	8	4	12
Increased value to organization	-*	8	4	12
Increased self-confidence	-*	8	3	11
Setting up tables, graphs, equations	-*	10	1	11
Understanding of co's work	-*	8	0	8
Is previous work experience in your scientific area a prerequisite for this position?				
No	-*	42	20	62
Yes	-*	31	11	42
Do you consider your position:				
Permanent	25	86	28	139
Temporary	1	7	6	14
Does your position provide opportunity for promotion?				
Yes	-*	48	22	70
No	-*	31	9	40
Do you consider yourself to be trained?				
Adequately	25	82	30	137
Overly	2	7	1	10
Inadequately	2	4	3	9
Services to which you refer work:				ABC
Duplicating	43	79	28	150

	A	B	C	ABC
Purchasing	27	65	24	116
Photography	22	59	16	97
Publications	19	43	19	82
Editing	13	26	10	49
Graphics	10	24	12	46
Data Processing	15	27	3	45
Translating	6	10	4	20

Recommended Training:

Scientific terminology	12	34	11	57
English	10	18	6	34
Basic science	5	19	7	31
Math	7	17	7	31
Technical typing	4	17	6	27
Chemistry	5	15	3	23
Basic secretarial skills needed first	7	12	2	21
Technical shorthand	3	11	3	17

II. Supervisor

A. Preliminary Run N = 22
B. Final Run N = 60
C. After Cut-off N = 16

1. Biographical Data:

Principal Product:	A	B	C	ABC
Research	3	10	2	15
Electronic products	2	6	1	9
R & D	1	6	1	8
Missiles	1	1	3	5
Missile components	1	2	2	5
Brick and tile	0	1	2	3
AEC contractor	2	0	1	3

Field of company:

Physics	2	9	3	14
Aerospace	1	8	3	12
Chemistry	1	7	2	10
Electronics	4	3	1	8
Engineering	0	4	4	8

	A	B	C	ABC
Mechanical Engineering	1	4	2	7
Biology	2	3	1	6
Metallurgy	2	1	0	3
Education	2	0	0	2
Type of organization:				
Industry	9	41	14	64
Government	7	6	1	14
Education	2	10	1	13
Type of research:				
Applied	11	27	10	48
Basic	3	9	2	14
Both	6	21	4	31
No. employees, total company:				
10,000	1	12	6	19
3,000-6,000	3	5	3	11
650-1,150	1	5	3	9
Under 500	1	6	2	9
No. employees, your dept.:				
20 and below	9	17	2	28
21-50	1	11	3	15
51-100	0	13	3	16
100-500	5	11	5	21
No. secretaries, total company:				
1-10	5	4	1	10
11-20	1	8	1	10
21-30	2	3	2	7
40-60	2	4	2	4
100-300	1	8	3	12
No. secretaries, your dept.:				
one	8	13	5	26
2-8	8	17	6	31
15-50	2	5	2	9

		A	B	C	ABC
Supervisor's title:					
Manager, division or dept.		4	17	5	26
Director, div. or program		5	10	3	18
(Remaining titles are predominantly administrative in all three samples.)					
No. of Ph.D.:		3	27	8	38
Main fields represented: all degrees:					
Physics		1	15	4	20
Chemistry		1	9	3	13
Electrical Engineering		1	5	2	8
Chemical Engineering		2	3	1	6
Aerospace		0	3	2	5
Math		0	3	1	4
No. employees you supervise in research jobs:					
1-10		7	12	3	22
11-20		1	16	2	19
No. employees you supervise in secretarial jobs:					
one		12	27	6	45
2-10		7	22	8	37
Percent of supervisor's time in:					
	%				
Administration	100	1	15	3	19
	40-60	6	10	2	18
Advising, consulting	10-25	8	22	5	35
Research lab	10	3	7	2	12
Teaching	10	2	3	1	6

2. Supervisor questionnaire and interview questions:

Worst secretary: tasks:				
Bad filing	4	4	4	12
Bad typing	3	5	1	9

	A	B	C	ABC
Evaluating importance of assignments	2	2	2	6
Best secretary tasks:				
Good typing	4	6	2	12
Good filing	6	3	2	11
Keeping informed on information applying to the business	4	1	1	6
Worst secretary traits:				
Not dependable	5	15	1	21
Inaccurate	4	8	3	15
Unintelligent	1	12	0	13
Bad attitude	0	8	4	12
Lack of initiative	5	6	0	11
Not responsible	1	9	1	11
Sloppy work	0	8	2	10
Can't get along with people	0	7	1	8
Inefficient	0	7	0	7
Not conscientious	4	1	1	6
Best secretary traits:				
Initiative	5	16	4	25
Intelligence	5	16	3	24
Efficient	1	12	7	20
Responsible	3	12	4	19
Accuracy	4	11	2	17
Good personality	1	6	4	11
Willingness and ability to learn	5	4	1	10
Attitude	4	2	2	8
Tact, poise	4	2	2	8
Dependable	4	1	1	6
Calm disposition	3	1	1	5
Fast worker	1	1	3	5
Worst secretary skills:				
Poor English	10	7	2	19
Poor typing	2	12	2	16

	A	B	C	ABC
Weak secretarial skills	6	2	2	10
Scientific terminology	2	2	5	9
Best secretary skills:				
Good typing	2	9	1	12
Good English	7	3	1	11
Good secretarial	7	2	2	11
Knows scientific terminology	4	1	6	11
Understands job requirements	1	6	1	8
Ideal secretary:				
Personality	3	29	7	39
Good typing	4	30	4	38
Good English	11	15	2	28
Basic secretarial skills	8	15	4	27
Shorthand	2	20	4	26
Technical terminology	6	16	3	25
Initiative	4	15	3	22
Efficiency	2	15	1	18
Intelligent	0	11	3	14
Responsible	1	10	1	12
Tact, poise	1	9	2	12
Knowledge of science	1	8	4	12
Dependable	3	7	1	11
Neat appearance	0	8	1	9
Understanding job requirements	0	7	2	9
Accuracy	6	2	0	8
Broad college education	1	5	1	7
Filing	4	1	1	6
If secretary is lacking, what sort of training would be of value to her?				
Technical terminology	4	6	2	12
Basic science	5	4	2	11
If secretary does not do technical or scientific tasks, who does?				
Research ass'ts., technicians	7	18	6	31

	A	B	C	ABC
Library	3	3	2	8
Technical drawing, drafting	3	1	1	5
Technical typists	0	3	0	3
What tasks would you turn over to your secretary if she were qualified?				
Routine administrative duties	0	13	3	16
Scanning technical publications for significant materials	1	7	1	9
Plotting data	2	2	3	7
Data reproduction	2	1	2	5
Set up special files	3	0	0	3
Training needed before secretary could perform above tasks:				
Basic science	0	5	1	6
Business understanding and administration	0	4	0	4
Do you have any on-the-job training?				
No	16	43	10	69
Occasional lectures or classes on procedures	2	5	2	9
Minimum necessary educational and training background for secretary:				
High school	6	5	7	18
Business or Jr. College	7	7	1	15
Some college desirable	0	12	1	13
Secretarial school	1	7	2	10
High school with science and math courses	1	6	0	7
Experience	1	5	1	7
More than 5 yrs. secretarial experience	0	3	3	6
Technical or scientific secretarial experience	1	2	3	6
High school with typing	2	2	1	5

	A	B	C	ABC
Comments on job description:				
Such a person would be highly desirable	2	19	1	22
Job description above secretarial level, but such a person would be valuable	1	14	6	21
Job description duties do not fit company's organization	3	4	2	9
Such a person would be indispensable	3	2	1	6
Anticipated changes during next decade:				
Increased automation of office procedure and equipment	8	14	9	31
Secretary will need more knowledge of automation and will do more data processing	2	4	2	8
More paper work, forms	0	6	0	6

III. Personnel Manager

A. Preliminare Run N = 21
B. Final Run N = 41
C. After Cut-off N = 10

	A	B	C	ABC
Qualifications looked for:				
Basic secretarial skills	13	38	7	58
Intelligence	3	17	5	25
English proficiency	8	10	5	23
Judgment, maturity	1	12	5	18
Technical terminology	1	12	3	16
Personality	1	8	4	13
Initiative	1	9	1	11
Experience	1	8	1	10

	A	B	C	ABC
Understanding of science	1	2	3	6
Willingness to learn	0	2	3	5

Most important qualifications:

	A	B	C	ABC
Basic secretarial skills	10	28	4	42
Intelligence	3	14	2	19
Judgment, maturity	1	10	2	13
Willingness to learn	1	6	2	9
Technical terminology	2	4	2	8
Initiative	0	7	1	8
English proficiency	4	3	0	7
Understanding of science	0	4	3	7
Personality	1	3	2	6
Neat appearance	1	2	2	5

Recommended Training:

	A	B	C	ABC
Scientific terminology	7	16	3	26
Basic secretarial skills needed first	5	10	3	18
English	9	7	2	18
Basic science	4	9	2	15
Math	0	9	1	10
Technical typing	1	7	1	9
Understanding research in govt., ind., & univ.	3	4	1	8
Business understanding	0	3	2	5

Would you pay technically trained secretaries higher salaries?

	A	B	C	ABC
Yes	5	20	8	33
No	8	5	2	15
Possibly	5	4	3	12
Faster advancement for secretary	5	2	1	8
Higher beginning job classification	1	6	2	9

Anticipated changes during the next decade:

	A	B	C	ABC
Secretary will have more responsibility	2	25	3	30
Automated office procedures and eqt.	3	18	4	25

	A	B	C	ABC
Automated typing procedures	5	10	3	18
More machine dictation	2	10	2	14
Little change in secretarial functions	3	4	4	11
Increase in the number of office machines	1	4	2	7
Greater decentralization	0	2	2	4

APPENDIX H

Final Composite Rating of Trainees

Trainee No.	Final Rating of Trainees
01	Top
02	Bottom
03	Bottom
06	Top
07	Middle
08	Middle
09	Bottom
10	Middle
11	Bottom
14	Middle
16	Bottom
18	Middle
19	Top
20	Top
21	Top
22	Middle
23	Middle
24	Top
28	Middle
29	Middle
30	Top
32	Middle
33	Bottom
34	Middle
35	Middle
36	Middle
38	Bottom
39	Top
41	Middle
42	Middle
43	Middle
44	Top
45	Top
46	Top

APPENDIX I

Evaluation of Scientific Secretary Training Program

Curriculum Objectives

The following is a list of specific objectives which the Scientific Secretary Training Program hoped to accomplish. How well do you think these objectives were met based on the performance of the SSTP trainee since September 27, 1966?

Please check the appropriate category on the rating scale below each of the objectives.

A. Secretarial Skills

1. Development of skill in technical typing (using preferred styles for typing equations, formulas, abbreviations and symbols).

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

2. Development of proficiency in taking and transcribing technical dictation.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

3. Development of concepts about writing technical reports and proposals.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

4. Development of skill in preparing technical documents for the printer.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

5. Development of skill in using, classifying and filing scientific material.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

6. Development of an understanding of office management and administration principles; planning, scheduling, and organizing procedures; and use of office machines.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

7. Development of an understanding of the need for accuracy, flexibility, tact, and patience in scientific secretarial work.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

B. Science

1. Development of a basic knowledge of scientific terminology.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

2. Development of an understanding of the scientist's frame of reference and the procedures, equipment, and language involved in scientific research.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

3. Development of a general, qualitative understanding of those basic principles and processes of the natural and physical science which will enable the secretary to function effectively in a scientific setting.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

4. Development of skill in the use of library facilities and familiarization with pertinent scientific reference materials.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

5. Development of an understanding of the interrelations among scientific fields.

1	2	33	44	5	6	7
very poor	poor	below average	average	above average	well	outstanding

C. English

1. Development of spelling accuracy.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

2. Development of knowledge of scientific vocabulary.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

3. Development of the ability to compose letters.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

4. Development of the ability to recognize errors in grammar, word usage, and syntax.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

5. Development of the ability to correct such errors and re-write sentences and paragraphs more effectively.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

D. Mathematics

1. Development of insight into and appreciation for advanced mathematical methods and language as these relate to scientific and technological research, including statistical analysis of data.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

2. Development of the ability to identify various mathematical symbols, expressions, and conventions.

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	well	outstanding

APPENDIX J

Report of Dropout Evaluation Questionnaires

N = 6 out of 10

A. General Reasons for Dropping	Frequency
1. Cannot afford to spend total time required	3
2. Changes in home responsibilities	2
3. Change in employment	1
4. Babysitting fee too expensive	1
B. Specific Reasons	
1. Too much homework in science	4
2. Weak science background caused difficulty in keeping up	4
3. Weak math background caused difficulty in keeping up	3
4. Lack of confidence in ability to master science material	3
5. Lack of confidence in ability to master math material	3
6. Work too difficult in science	3
7. Too much material covered in science	3
8. Too much material covered in math	2
9. Work too difficult in math	2
10. Too much homework in math	1
11. Math material covered not what was expected	1
12. Math material presented too vague	1
13. Skills material covered not what was expected	1
14. Weak skills background caused difficulty in keeping up	1
15. Too much skills homework	1
16. Too much shorthand homework	1
17. Weak English background caused difficulty in keeping up	1
18. Increased job responsibilities demand too much of trainee's time	1
C. Aspects of the Course Found to be too Difficult	
1. Math	3
2. Science	2
D. Aspects Found to be too Easy	
1. Typing	1
E. Phase Considered most Worthwhile	
1. Science	2
2. Skills	1
3. English	1

F. Phases Considered of Little Importance

	Frequency
1. Certain phases of the skills class	1
2. Too much emphasis on shorthand	2
3. Math, because it was not understandable	1

G. Most Important Factors Influencing Decision to Drop Out

1. Time factor	2
2. More outside work required than anticipated	1
3. Babysitting cost	1
4. Math too difficult	1

H. Suggestions for Improving the Program

1. Have one session weekly of each class	1
2. Good secretarial skills should be a prerequisite for admission into the program so that more time can be allotted for science and math	1

Additional Comments

1. Time commitment too demanding	2
2. Two periods a week would be better	1
3. Poor background plus time factor made it impossible to keep up	1
4. Program is excellent for those with time	1
5. Instructors were very good	1

Location of Dropouts (N = 10)

1. Boulder	6
2. Denver vicinity	1
3. Louisville	1
4. Longmont	1
5. Eldorado Springs	1

Group Dropouts were in (N = 10)

1. B	8
2. A	2

APPENDIX K

Trainees' Most Frequent Comments on U. Ratings and Further Comments	Frequency			
	1st Eval.*	2nd Eval.*	3rd Eval.*	Total
A. Comments on Homework				
1. Not enough time for homework	7	2	1	10
2. Assignments reasonable but unrealistic; because of lack of background takes much more time than 2 hours a week	5	1	3	9
B. Comments on Course Schedule				
1. Wants more time for math	7	16	12	35
2. Suggests longer course - 2 years	2	4	5	11
3. More basic math course	-	3	2	5
C. Comments on background course requirements and own background				
1. Weak math background	19	12	11	42
2. Weak science background	18	11	12	41
3. Class too diverse in math background	4	-	3	7
4. Weak skills background	2	1	3	6
5. Weak in shorthand	4	-	-	4

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* first evaluation - 12/66; second evaluation - 6/67; third evaluation - 12/67

Trainees' Most Frequent Comments on U Ratings and Further Comments

D. Comments about the classes and content	Frequency			
	1st Eval.	2nd Eval.	3rd Eval	Total
Skills				
1. More emphasis on technical typing and shorthand	-	1	2	3
2. Wants more typing and time to get used to new typewriter	2	-	1	3
Science				
1. Approach needs improvement	2	-	4	6
2. Science too difficult	5	1	-	6
3. Too much to learn	4	-	1	5
4. Terminology enough for scientific sec.; understanding not necessary	4	-	1	5
5. More time needed to learn material	-	5	-	5
Math.				
1. Too much depth; understanding not necessary for scientific secretary	7	2	4	13
2. Math too difficult	2	2	4	8
3. Should have been given the fundamentals earlier	3	-	3	6
4. Should have been given the math workbook sooner	4	1	-	5
5. Wants more problem solving in class	4	-	-	4
6. Math not important	4	-	-	4
7. More demonstration of math symbols, formulas, and correct typing placement	-	1	3	4

Trainees' Most Frequent Comments on U Ratings and Further Comments

	Frequency			
	1st Eval.	2nd Eval.	3rd Eval.	Total
English				
1. Instruction too elementary	1	3	3	7
2. Instruction not broad enough	1	2	2	5
3. Wants more technical English practice	2	2	1	5
E. Phases of program considered most worthwhile				
1. Skills	20	17	17	54
2. Science	10	9	16	35
3. All phases	13	11	4	28
4. English	7	6	5	18
5. Math	6	2	3	11
6. Terminology	6	-	4	10
7. Shorthand	5	-	2	7
8. Technical typing	2	-	2	4
F. Comments about instructors (as mentioned in regard to U ratings or under additional comments)				
1. Likes instructors	5	5	1	11
2. Math presentation not clear	3	3	2	8
3. Likes English instructor	3	-	1	4
G. Special problems mentioned				
1. Irrelevant questions in science and math waste class time	5	-	-	5
2. Some class members too competitive	3	-	1	4

Trainees' Most Frequent Comments on U Ratings and Further Comments

	Frequency			
	1st Eval.	2nd Eval.	3rd Eval.	Total
H. Miscellaneous comments				
1. Course has stimulated a desire for further study	3	5	5	13
2. Likes program	10	-	-	10
3. It's up to the individual to get as much as possible out of the course	3	1	2	6
4. Course worthwhile experience, even though it may not lead to a better job immediately	1	-	4	5
5. Frequent testing a good idea	2	1	1	4
I. Least important				
1. Solving math problems	-	7	2	9
2. English	-	4	5	9
3. Math	-	3	5	8
4. Higher math., i.e., calculus, geometry	-	3	1	4

APPENDIX L

Pretest and Wechsler Adult Intelligence Scale Results

Test	N	Total Range	Actual Range	$\overline{M}$	SD	Median
*Typing, 5 min. straight copy	46					
Gross wpm		0-∞	39-81	61.3	10.5	61.0
Errors (Mode = 6)		0-∞	00-37	8.9	9.0	5.0
*Typing, 10 min., rough draft	46					
Gross wpm		0-∞	13-47	32.6	8.2	34.0
Errors (Mode + 1)		0-∞	00-06	1.8	1.5	0.9
*Typing, 5 min., statis. copy	46					
Gross wpm		0-∞	30-75	54.2	9.9	55.3
Errors		0-∞	01-31	8.0	6.8	7.0
*Dictation	46					
**Weighted wpm		0-∞	00-56	13.6	9.8	15.0
***Rate (Mode = 2)		1-4	1-4	2.5	0.9	2.5
% Accuracy		0-100	00-99	75.8	34.2	92.7
English	46					
Coop Expression		0-90	28-87	57.8	15.2	60.0
DAT Spelling		0-100	48-100	90.7	9.8	94.5
DAT Sentences		0-95	27-85	62.0	13.6	63.7

*Used for determining placement in Group A or B.
**Gross wpm times dictation rate in wpm/100 = weighted wpm.
***Rate Code: 1 = 110 wpm; 2 = 90 wpm; 3 = 70 wpm; 4 = 00 wpm

Test	N	Total Range	Actual Range	$\overline{M}$	SD	Median
Minnesota Clerical	44					
Number Comparison		0-200	86-189	138.0	23.1	137.6
Name Comparison		0-200	96-194	154.3	25.5	156.7
Mathematics	44					
Problems		0-15	4-15	8.9	2.8	9.5
Symbols		0-33	6-22	13.0	3.8	13.7
Science	44					
Total score		0-100	17-51	30.2	7.3	29.5
Physics		0-33	3-14	8.2	2.4	8.5
Chemistry		0-20	0-13	5.6	2.2	5.0
Biology (Mode = 4)		0-6	0-6	3.7	1.4	3.3
Earth Sci. & Astron.		0-25	1-13	7.7	2.7	8.3
Computers & Math.		0-16	2-9	5.0	1.7	5.3
WAIS	39					
Total IQ		41-157	100-134	116.1	7.7	116.2
Verbal IQ		41-157	101-139	118.2	8.9	117.0
Performance IQ		41-157	96-127	111.4	8.2	113.7

APPENDIX M

Summary Report of Dropout Pretest and WAIS Scores

Pretests and WAIS	Dropout Mean	Total Mean
Typing, 5' straight copy		
Gross wpm.	57.4	61.3
Errors	12.2	8.9
Typing, 10' rough draft		
Gross wpm.	27.5	32.6
Errors	1.5	1.7
Typing, 5' straight copy		
Gross wpm.	49.0	54.1
Errors	12.0	7.9
Dictation		
*Weighted wpm.	9.8	13.6
**Rate	2.9	2.5
% Accuracy	60.3	75.8
English		
Coop Expression	47.3	58.8
DAT Spelling	81.0	90.7
DAT Sentences	59.9	61.9
Minnesota Clerical		
Number Comparison	130.1	137.9
Name Comparison	139.3	154.2
Mathematics		
Problems	8.5	8.9
Symbols	12.5	13.0
Science		
Total	28.0	30.2
Physics	7.8	8.1
Chemistry	4.8	5.6
Biology	3.0	3.6
Earth Sci. & Astron.	7.9	7.7
Computers & Mathematics	4.5	5.0
Wechsler (WAIS)		
Total IQ	111.8	116.0
Verbal IQ	107.2	118.1
Performance IQ	110.0	111.4

*Gross wpm times dictation rate in wpm/100 = weighted wpm for transcription

**Rate code: 1 = 110 wpm; 2 = 90 wpm; 3 = 70 wpm; 4 = 00 wpm

APPENDIX N

Correlational Analysis of Final Scientific Secretary Training Program Trainee Rating with 49 Variables

(1 = top third; 2 = middle third; 3 = bottom third; 4 = dropout)

Pearson r	Variable Name	Pearson r	Variable Name
+.79	Length of time in the program	+.35	Weighted wpm. (dictation rate wpm/100 x transcription wpm)
+.61	DAT English Spelling	+.33	WAIS Digit Span
+.57	English Cooperative Expression	-.32	5 min. straight copy errors pre-test
+.51	WAIS Verbal IQ	+.31	High school rank percentile
+.51	Shorthand speed on application	+.30	Science Biology subtest
+.48	WAIS Information	-.30	5 min. statistical copy error pre-test
+.47	10 min. rough draft gwpm.	+.28	WAIS Arithmetic
+.46	Minnesota Clerical Name Comparison	+.24	Math Symbols
+.45	WAIS Total IQ	-.23	Science: Computer and Math subtest
+.44	WAIS Vocabulary	+.23	Age on application
+.42	Science Chemistry subtest	+.22	Typing speed on application
+.40	5 min. statistical copy type gwpm.	+.22	Size of high school graduate class
+.39	Shorthand dictation rate	+.21	DAT English Sentences
+.37	Science Total Score	+.21	No. of years of previous employment
+.37	5 min. straight copy type gwpm.	+.21	Science Physics subtest
+.36	Shorthand % accuracy		

Pear-son r	Variable Name	Pear-son r	Variable Name
+.19	WAIS Similarities	+.13	Math problems
+.18	WAIS Performance IQ	+.13	WAIS Digit Span backward
+.18	Minnesota Clerical No. Comparison	+.13	Science: Earth Science and Astronomy subtest
+.18	WAIS Comprehension	-.08	WAIS Information (science score)
-.16	10 min. rough draft errors pre-test	-.08	WAIS Digit Span forward
-.15	WAIS P.C. Perspective	+.06	WAIS Object Assembly
-.14	WAIS Picture Assembly	+.03	WAIS Digit Symbol
-.14	WAIS Picture Completion	-.02	Application # of previous full time jobs
+.14	WAIS Block Design		
		+.01	Years of education on application

APPENDIX O

Correlation Analysis of 49 Variables with the Length of Time Remaining in the Scientific Secretary Training Program

Pearson r	Variable Name	Pearson r	Variable Name
+.78	Final rating	+.23	WAIS Arithmetic
+.58	DAT English Spelling	+.22	WAIS Block Design
+.48	English Cooperative Expression	-.22	5 min. straight copy errors
+.42	WAIS Verbal IQ	+.22	WAIS Vocabulary
+.40	Minnesota Clerical Name Comparison	+.20	Science Chemistry subtest
+.38	WAIS Total IQ	+.19	Weighted dict.-transcription wpm.
+.35	10 min. rough draft gwpm.	+.18	Science Biology subtest
-.33	WAIS P.C. Perspective	+.18	5 min. straight copy gwpm.
+.32	Age on application	+.18	Science Computer and Math subtest
-.31	5 min. statistical errors	+.18	WAIS Performance IQ
+.31	Shorthand speed on application	+.18	Science Total Score
+.30	No. of years of prev. employ.	+.17	WAIS Similarities
+.30	WAIS Information	+.16	Shorthand % accuracy
-.30	WAIS Picture Completion	+.15	WAIS Comprehension
-.28	Shorthand rating	+.15	Science Physics subtest
+.26	5 min. statistical copy gwpm.	-.13	Years of Education
+.25	WAIS Digit Span	+.12	DAT English Sentences
+.24	Minnesota Clerical No. Comparison	+.12	Math Symbols

Pearson r	Variable Name	Pearson r	Variable Name
+.32	High school rand %ile	-.08	10 min rough draft errors
+.11	Typing speed on application	+.08	Size of high school graduating class
-.11	WAIS Digit Symbol	-.06	WAIS Digit Span forward
-.11	# of previous full time jobs	+.03	WAIS Object Assembly
+.11	Math problems	-.03	WAIS Digit Span backward
-.10	WAIS Picture Arrangement	+.021	WAIS Information (Science Score)
+.09	Science: Earth Science and Astronomy subtest		

APPENDIX P

Multiple Correlation with Improvement in Science

Pearson r	R	S.E.*	Variable
+.477	.478	1.09	DAT Spelling
-.324	.568	1.03	WAIS P.C. Perspective
+.389	.640	0.97	Science Chemistry
+.347	.674	0.95	Years of Previous Employment
+.143	.713	0.91	DAT Sentences
+.246	.753	0.87	WAIS Similarities
+.190	.786	0.83	Science Biology
+.446	.809	0.80	Coop. Expression
-.040	.821	0.78	5 min. Straight Copy Errors
+.363	.840	0.76	10 min. Rough Draft Gwpm.

*Standard Error of Estimate

APPENDIX Q

Multiple Correlation with Improvement in Math.

Pearson r	R	S.E.	Variable
+.435	.435	1.01	DAT Spelling
+.034	.502	0.98	10 min. Rough Draft Errors
+.324	.564	0.95	Years of Previous Employment
+.307	.612	0.92	WAIS Verbal IQ
+.043	.681	0.86	DAT Sentences
-.070	.708	0.84	Size of High School Grad. Class
+.266	.732	0.82	Science Chemistry
-.362	.755	0.80	Shorthand Rating
+.169	.791	0.76	Weighted Dictation-Transcription Rate
-.107	.808	0.74	WAIS Digits Forward

APPENDIX R

Multiple Correlation with Improvement in English.

Pearson r	R	S.E.	Variable
+.566	.566	0.95	Coop. Expression
+.462	.693	0.84	Age on Application
+.426	.732	0.81	Shorthand Speed on Application
-.222	.755	0.78	WAIS Picture Completion
+.222	.791	0.74	Weighted Dict.-Trans. Rate
+.305	.811	0.72	WAIS Digits Span
-.200	.825	0.71	WAIS Digits Forward
+.275	.836	0.70	WAIS Stock Design
-.030	.847	0.68	WAIS Object Assembly
+.431	.863	0.66	WAIS Total IQ

APPENDIX S

Multiple Correlation with Improvement in Clerical Skills.

Pearson r	R	S.E.	Variable
+.577	.577	0.89	DAT Spelling
+.499	.646	0.85	Shorthand Speed on Application
+.352	.691	0.81	Age on Application
+.322	.733	0.77	Science Chemistry
-.349	.772	0.73	WAIS Picture Completion
+.305	.797	0.71	WAIS Total IQ
+.164	.817	0.68	DAT Sentences
+.498	.841	0.65	Coop. Expression
+.205	.859	0.62	WAIS Similarities
+.116	.872	0.61	WAIS Information (Sci.)

APPENDIX T

Scientific Secretary Training Development Program

Curriculum Guide

for

Secretarial Skills

I. Course objectives

   A. To improve basic secretarial skills, including typing, shorthand, and use of office machines.

   B. To develop proficiency in technical typing, with understanding of preferred styles for typing equations, formulas, abbreviations, and symbols.

   C. To develop proficiency in taking technical dictation and in transcription.

   D. To develop concepts about writing technical reports and proposals and skill in typing such documents.

   E. To develop skill in using, classifying, and filing scientific documents.

   F. To develop understanding of the principles of office administration (planning, organizing, coordinating, and supervising) as they apply to the scientific secretary.

   G. To develop understanding of special duties which are often a part of the job of the scientific secretary; for example, making arrangements for conferences and meetings, receiving and helping international visitors, making travel arrangements, and preparing data for computer processing.

   H. To develop an understanding of the crucial need for accuracy, flexibility, tact, and patience in scientific secretarial work.

   I. To reinforce the learning in science and mathematics by coordinating the materials used for typing and shorthand.

II. Instructional materials

A. Published materials:

Appropriate sections of the following books were used as text material:

1. Adams, Dorothy, and Kurtz, Margaret
   The Technical Secretary: Terminology and Transcription
   McGraw-Hill Book Company, Inc., New York, 1968
   (In this course, duplicated copies of the manuscript were used, with permission of the authors and the publisher.)

2. Stafford, Alison R., and Culpepper, Billie Jean
   The Science-Engineering Secretary
   Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1963

3. Strony, Madeline S., Garvey, M. Claudia, and Newhouse, Howard L.
   Refresher Course in Gregg Shorthand Simplified
   McGraw-Hill Book Company, Inc., New York, 1962

4. Terry, George R.
   Office Management and Control, fifth edition
   Richard D. Irwin, Inc., Homewood, Illinois, 1962

5. Wanous, S. J.
   Statistical Typing with Tabulation Problems, second ed.
   South-Western Publishing Company, Chicago, 1956

In addition to the textbooks listed, the following reading references were used:

1. Bell Telephone Laboratories, Inc.
   The Preparation and Typing of Mathematical Manuscripts
   Bell Telephone Laboratories, Inc., New York, 1963

2. Dunford, Nelson James
   A Handbook for Technical Typists
   Gordon & Breach, New York, 1964

3. Gregg, John Robert, Leslie, Louis A., and Zoubek, Charles E.
   Gregg Shorthand Dictionary (Anniversary and Simplified)
   McGraw-Hill Book Company, Inc., New York

4. Harwell, George C.
   Technical Communication
   The Macmillan Company, New York, 1960

5. Schultz, Howard, and Webster, Robert G.
   Technical Report Writing
   David McKay Company, Inc., New York, 1962.

6. Today's Secretary, monthly magazine
   McGraw-Hill Book Company, Inc., New York.

7. Uvarov, E. B. and Chapman, D. R. (third edition, revised by Isaacs, Alan)
   Dictionary of Science, third edition
   Penguin Books, Baltimore, Maryland, 1964.

B. Unpublished materials prepared by the teacher:

1. Technical dictation material: articles selected from newspapers, magazines, trade journals, and special reports; letters from scientific offices. (For examples see Addendum No. 1.)

2. IBM dictation belts, with shorthand previews, for practice in taking technical shorthand at progressive speeds. (For examples of material and previews, see Addendum No. 2.)

3. Technical material for typing from rough draft copy, collected from scientific offices. (For examples, see Addendum No. 3.)

4. Technical material for typing from handwritten copy, prepared by the science and mathematics teachers. (For examples, see Addendum No. 4; also, course outline for mathematics.)

5. Study guides to aid in understanding terminology and content of technical dictation. (For examples, see Addendum No. 5.)

6. Examinations. (See Addendum Nos. 5 and 6.)

III. Methods of instruction

The students were divided into two groups according to their scores on the pretests in shorthand and typing. However, even after this division, there was a wide range of ability within each group; therefore, class activity was kept as flexible as possible in order that each student could progress at her own rate.

A. Technical Typing

1. Intensive review of techniques of typing numbers and of setting up tabulations. Class discussion, class drills, and problem assignments in Statistical Typing with Tabulation Problems by S. J. Wanous.

2. Class discussion of preferred styles of typing various kinds of technical material. Each student was asked to compose her own reference notebook on technical typing, based on class discussion and assignments in reading and typing throughout the first semester.

3. Teacher demonstration of special technical typing aids, such as Typits, interchangeable keys, templates, and transfers; practice exercises for the students to gain skill in handling each device.

4. Typing assignments in The Science-Engineering Secretary by Allison R. Stafford and Billie Jean Culpepper, with emphasis on learning preferred styles and formats; assignments in other books and manuals, with emphasis on comparison of styles.

5. Production typing from rough drafts of technical material in science, engineering, and mathematics, with emphasis on application of techniques and styles learned in (3) and (4) above. (Addendum No. 3.)

6. Typing from Xeroxed copies of handwritten information sheets collected from the mathematics and science teachers; emphasis on application of rules and techniques of technical typing and reinforcement of learning in these subject areas. (Addendum No. 4.)

7. Lecture-demonstrations by visitors, followed by typing assignments to apply new learning.

    a. Technical report typing. Mr. Gill Riordan, in charge of technical report preparation at Rocky Flats Division of Dow Chemical, gave two lectures.

    b. IBM Universal Element.
    Mr. William Saleh, representative from IBM, Boulder.

    c. IBM Executive typewriter (with proportional spacing).
    Mr. William Saleh, representative from IBM, Boulder.

B. Shorthand dictation and transcription

1. Intensive review of basic shorthand theory and transcription techniques. Progressive speed building. Refresher Course in Gregg Shorthand Simplified by Madeline S. Strony, Claudia M. Garvey and Howard L. Newhouse was used as the text.

2. Word study, building shorthand forms for technical words. Emphasis on learning prefixes, suffixes, combining forms, and short cuts. Rapid word dictation.

3. Word study, building understanding of scientific terminology. Class discussion of spelling, definitions, and specific usage in scientific and mathematical material.

4. Word study, combining understanding of terminology and writing shorthand. Rapid sentence dictation, paragraph dictation, using technical terms in proper context.

5. Guided study periods. Practice writing shorthand from text material; practice taking the same material in dictation from the teacher or at the IBM practice stations.

6. Timed transcription of selected portions of the dictation. Emphasis was usually on accuracy. At intervals, speed in transcriptions was emphasized to help the students adjust to working under pressure.

7. New material dictation in related subject areas.

8. Short dictation-transcription tests at frequent intervals, to motivate study and to gauge progress.

C. Office Administration and special duties

1. Lectures, shorthand dictation, and class discussion on assigned topics.

2. Assigned problems, using information gained in lectures and discussions.

3. Field trips and visiting lecturers.

    a. Data Processing.
    Lecture by Mr. Richard Webb, Colorado Instruments, Inc.

"Introduction to the Computer."
Lecture by Mr. John Kline, University of Colorado
"Layman's Explanation of Solid State Circuitry."

b. Communications.
Field trip to Communications Center, Denver.

c. Public relations; supervision and co-ordination; systems; filing and records management.
Lectures by Dr. F. K. Bangs, University of Colorado.

IV. Units of instruction

Half of the 320 hours of in-class time scheduled for the Scientific Secretary Training Program were allocated to secretarial skills. This meant that each student spent approximately five class hours each week for 32 weeks developing secretarial skills. The units of work had to be planned to allow study time in class since outside assignments were to be kept to a minimum.

During the first semester these five class periods were divided almost equally between typing and shorthand. During the second semester one class period each week was used for Office Administration and Special Duties, and the remaining class periods (four) were divided between typing and shorthand.

The following units of instruction were covered in this allocated time:

Unit 1. Intensive review to build basic skills (40 class hours, including diagnostic testing).

(a) Typing numbers; proofreading numbers; tabulating.
(b) Shorthand theory; progressive speed building.
(c) Office machines (time arranged according to need).

Unit 2. Technical typing (20 class hours, first semester; 32 hours, second semester).

(a) Special tools for the technical typist: Typits, interchangeable keys, transfers, templates, special keyboards, technical element for IBM Selectric.

(b) Preferred styles for technical typing: symbols, equations, formulas, abbreviations, reports and manuscripts.
(c) Greek alphabet: typing the alphabet using the Selectric element; building letters of the alphabet on a regular typewriter; learning to recognize letters of the alphabet in handwritten copy.
(d) Typing technical material from rough drafts.
(e) Typing technical material from handwritten copy.

Unit 3. Technical shorthand (20 class hours, first semester; 32 class hours, second semester).

(a) Building skill in writing and transcribing technical material, based on the units provided in *The Technical Secretary: Terminology and Transcription*:

Hydrocarbons and Petro-chemicals
Synthetics
Life Sciences
Aerospace
Electronics
Communications
Nucleonics

(b) Building skill in taking dictation from new material in related areas.

Unit 4. Office Administration and Special Duties (16 class hours, second semester).

(a) Public Relations
(b) Information Handling (filing and records management)
(c) Supervision and Co-ordination

1. Planning ahead, rush periods, special projects
2. PERT and other progress charts
3. Giving instructions, preparing manuals, programmed learning

(d) Systems Analysis (paperwork)

1. Forms and forms control
2. Flow process
3. Work simplification (standards and measurements)
4. Work simplification (job and motion analysis)
5. Office layout

(e) Special Duties

1. Travel arrangements
2. Arranging conferences; taking minutes of meetings
3. Preparing information for data processing

Addendum No. 1 Technical Dictation Material

This material, collected from newspapers, trade journals, special reports, and letters from scientific offices, was edited so that the copy would be of appropriate difficulty for proper learning.

Much of the material was selected to correlate with text units in shorthand and/or with subject area in science.

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GEOLOGY

Future Oil From Rocks

The vast sources of oil from shale deposits will become increasingly exploited as mining methods improve and better means are found of extracting oil—By Barbara Tufty

➤ TOMORROW'S OIL may come not from wells, but from rocks throughout the world.

The world may contain 900 trillion tons of organic matter rich in oil, with an energy potential about 18,000 times the amount the world consumes each year, according to a report released by the U.S. Geological Survey, Department of Interior.

This is the first report to summarize the energy potential of rich oil shales of the United States and other parts of the world.

About 190 billion barrels of oil could be extracted under present conditions, reported Donald C. Duncan and Vernon E. Swanson of the Geological Survey's offices in Washington, D.C., and Denver, Colo.

About 325 trillion barrels are estimated in lower grade oil shales which are less accessible.

The enormous land areas of Asia include the largest deposits of oil shale—about 500 trillion tons of higher grade shale. The large land mass of Africa is next with about 370 trillion tons, the geologists estimate. The United States has about 120 trillion tons. For thickness and quality of the shale, the outstanding deposit of the world is in the rich Green River Formation of Colorado, Utah and Wyoming.

Oil shale is a type of rock formed by layers of deposited material rich in organic or once-living matter. It is composed mainly of remains of small plants, principally algae, which are rich in fats and waxes and which have partly decomposed under water. This material yields oil when heated in the absence of air.

Shale deposits were formed more than 600 million years ago, in the Cambrian period, and are still being formed in certain areas of the world, such as the northern lakes of North America, the fjords of Scandinavia and some coastal swamps and lagoons.

Some of the oil shale deposits have been mined in Scotland, France, Russia, Estonia, Sweden, Germany, Spain, South Africa, Australia and Manchuria. The largest oil shale industry in the world was started by the Japanese in Fushun, Manchuria, and has been developed by the Red Chinese.

There is continuing interest in obtaining oil from oil shales whenever the petroleum supply runs low. As mining methods improve and better methods are found of extracting the oil, these vast sources of oil will be more exploited, Mr. Duncan believes.

• Science News Letter, 89:71 January 29, 1966

Colorado School of Mines

LEAF-SHAPED CRYSTALS—This ten-inch specimen of a tungsten compound showing leaf-shaped blades of crystal is on display at the mineral collection at Colorado School of Mines. Crystals such as these grow slowly underground for thousands of years.

GEOLOGY

Rich Oil Produced In California Basin

➤ THE LAND BASIN around Los Angeles, one of the world's greatest oil producing areas, accounts for over six billion barrels of crude oil produced in the last 83 years, according to a report published by the U.S. Geological Survey.

The 2,600-square-mile area, bordering on the Pacific Ocean and extending northwest to the San Fernando Valley vicinity, northeast to the San Gabriel Mountains and south to Newport Bay, contains rocks that span a period from one million to 100 million years in age.

The area around Los Angeles has produced as much as 93 million barrels of petroleum per year, nearly one-third of California's total production, said R. F. Yerkes, geologist at the Survey headquarters in California and co-author of the report, "Geology of the Los Angeles Basin, California—An Introduction."

• Science News Letter, 89:71 January 29, 1966

CONSERVATION

'Frail Lands' in U.S. To Be Rehabilitated

➤ THE UNITED STATES has 45 million acres of "frail" public lands, lands where the wind blows free, the rain beats down and the topsoil blows and washes away, according to a recent survey by the Bureau of Land Management of the Department of Interior.

Projects are underway to rehabilitate these lands, found in all western states, by methods such as rebuilding the depleted soils, building fences to prevent wind erosion, and planting vegetation to hold the soil from washing away.

• Science News Letter, 89:71 January 29, 1966

GEOLOGY

New Mineral Collection One of World's Biggest

➤ ONE OF THE WORLD'S largest mineral collections, which includes a piece of turquoise as big as a cantaloupe and a naturally-occurring sheet of copper the size of a dishpan, has been formed at the Colorado School of Mines.

The school's collection was more than doubled by contributions from the Colorado State Historical Society which gave its own rocks and minerals after almost a year of negotiations.

More important to the School of Mines than the miscellaneous rocks, gems and geological oddities, however, are the core samples—layer by layer records of rock strata—of which the school has 138,000, and the mined ores. Only the Smithsonian Institution in Washington and another collection in Germany are more complete in this field, said G. A. Franz Jr., Deputy Commissioner of the Colorado State Bureau of Mines.

• Science News Letter, 89:71 January 29, 1966

TECHNOLOGY

Radiation: Food's New Keeper

By harnessing the nuclear energy from radioactive cobalt and other sources, scientists are now using the atom's power to preserve nature's bounty for man's nourishment.

By BARBARA TUFTY

See Front Cover

➤ NUCLEAR RADIATION is offering an awesome and safe transformation to modern man's living.

Just as the inventions of the tin can over 150 years ago and the frozen food package two decades ago revolutionized the storage and handling of food, now atomic energy may change the looks of the housewife's kitchen and bring new foods to faraway places.

By exposing food to harmless doses of energy rays, scientists find they can destroy the microorganisms that cause spoilage and decay in nature's meats, fruits and other nutrients.

A few doses of energy rays prevent potatoes from sprouting, as shown in the picture on this week's front cover of white potatoes left in the open for six months. The radiated potato is on the left. Source of the radiation is cobalt 60, glowing from the bottom of a pool of water at U.S. Army Laboratories, Natick, Mass.

Benefits of Radiation

The radiated food, wrapped in flexible containers, can be kept indefinitely on shelves at ordinary temperatures, looking as juicy and bright as the day it arrived. Because of lightness in storage weight and no need of refrigeration, such foods could easily travel to newly developing countries where they are urgently needed—and just as easily, exotic tropical fruits could be decontaminated of foreign microbes and be transported to your table.

Food—the chickens, fish, beef, peaches, strawberries, wheat, nuts and more than 5,000 odd varieties of plants and animals that supply man with energy and nutrition—deteriorates naturally soon after it is cut or killed. This spoilage is the result of chemical processes that break down tasty substances into compounds that are unpalatable to human beings and other creatures.

Several agents can bring about this food spoilage, but the major damages are caused by the action of tiny living organisms such as bacteria, molds and yeasts that force their way into cracks, cuts and bruises of food and there continue their life processes. Another important reason food spoils is the action of enzymes, those complex substances that are naturally present in living material and function as catalysts to accelerate certain living processes. Then there are various chemical reactions, such as oxidation, whereby chemicals of the food react with chemicals of the air or environment to form new, unpleasant substances.

This food deterioration can be slowed down or even stopped in several ways, simply by destroying the spoiling agents or by depriving them of things they need, such as water, warmth, air or light.

Throughout the ages, man has managed to slow down the evils of decay by various ingenious methods—drying, salting, pickling, smoking, baking, canning, cooling, freezing, waxing, bottling and packaging. Now he is trying radiation.

Man has come a long way from the days a few hundred thousand years ago when he hovered over his meat drying above red glowing embers to now, when he stands above the 25-foot pool of water watching the eerie blue light around the radioactive cobalt.

Probably the oldest method of preserving food is that of drying. Prehistoric man may have noticed that dried grains, berries and nuts kept for a long time without spoiling, so he started drying meats and fish in the sun and air or smoking them over a fire. In the northern countries, he learned to preserve a piece of meat by packing it deep in a snow bank—a primitive deep freeze.

Salt has been used for ages as a preservative, mainly for meats and fish. By adding water to the salt, or brine, the art of pickling was invented. Later, sugars and spices were added to fruits and vegetables to provide stores of jams, jellies and preserves through the non-growing seasons.

It wasn't until about 1795, however, that man first devised a mechanical process for preserving foods—the hot air dehydration chamber, constructed in France.

First Tin Can

The first tin can—a nickname for the word canister—was created in a simple kitchen by the French confectioner, Nicholas Appert, in response to a reward offered by Napoleon for a method of keeping his military men fed as they moved across Europe or sailed on the seas for long months. Without understanding why, Appert found that food heated in sealed containers did not decay and retained its texture and taste for a long time.

Fifty years later, the French scientist Louis Pasteur looked through his microscope and discovered the existence of tiny living creatures—bacteria. Later he proved that these actually caused food to spoil.

Gradually systems for canning, cooling, freezing and salting foods spread throughout Europe and newly developing America. At the end of the 19th century mechanical refrigerators began to be installed in homes.

Another big revolution in food processing came in the 1920's when Clarence Birdseye overcame tremendous obstacles to develop and sell his quick-frozen products. Only in the late 1940's was this freezing process established as an important competitor to conventional preserving methods. Innovations on this method include dehydration or freeze-drying, whereby water is removed.

Now scientists are trying a brand new process of bombarding the decay-creating organisms with electrons or rays from radioactive sources.

This radiation may be given in small pasteurizing doses which kill some microorganisms but retain the flavor, odor, texture and shape of the original food. Larger doses, ten to a hundred times stronger than the smaller doses, sterilize the food and kill virtually all bacteria.

It is important to remember that this radiation does not leave behind a radioactive residue and is not harmful to anyone who eats these foods. Substances are made dangerously radioactive only when heavy doses of nuclear particles from tremendous energy sources such as the atom bomb or an atomic reactor penetrate and break up the nucleus of the object bombarded. The rays used for preserving foodstuffs are nowhere near so powerful.

U.S. Army Involved

The process of food radiation began after World War II, when isotopes became readily available. As military establishments of every country are always interested in better methods of preserving foods, the U.S. Army has been consistently working on this new research, experimenting in particular with large doses for complete sterilization of foods at their laboratories in Natick, Mass. The Atomic Energy Commission, interested in lighter pasteurization doses, has built a Marine Products Development Irradiator at Gloucester, Mass., to demonstrate the process to the seafood industry.

A typical pasteurization dose contains about 250,000 rads. (A rad is a standard unit of measurement of radiation absorbed by an object.) Scientists figure a few thousand rads inhibit sprouting of potatoes and onions; tens of thousands kill grain insects and meat parasites; a hundred thousand to a million rads kill most microbes in meats, fruits and vegetables; and over a million rads kill all microbes.

For this process essentially two sources of radiation are used. One source is a powerful by-product from AEC nuclear reactors—cobalt 60 or cesium 137. In the AEC irradiator, four activated cobalt slugs are inserted inside a tube of stainless steel which in turn is inserted into an aluminum tube. There are two rows of these tubes, 49 in each row. This collected activated cobalt source constantly sends out gamma rays of approximately 250,000 curies. (A curie is a standard unit of measurement used to describe the intensity of radioactivity in a given amount of radioactive material. One curie equals

Pilots Given New Eyes

Microwave radio, ending the era of blind flying, sends a picture of runway and lights to a screen inside a plane still 10 miles from the airport—By Charles A. Betts

▶ **THE HAZARDS** of blind flying, the fog, rain, snow and low-hanging overcasts that have plagued aviation safety and schedules since man first began to fly, soon should be overcome by modern science's use of microwave radio signals.

After a period of preliminary experimentation, the Federal Aviation Agency is scheduled to give final tests this summer to a new all-weather landing aid that lets the pilot see his runway on a special screen through any weather obstacle up to 10 miles away.

The new system, developed by the Bendix Corporation's Eclipse-Pioneer division at Teterboro, N.J., and called "Microvision," uses microwave radio signals, beamed to the plane from both sides of the landing strip, to put a picture of the runway up through fog and clouds into the cockpit of the plane.

The system has been in the development stage for about five years at Bendix. In 1965 a contract was signed with the FAA to install the electronic runway markers at the FAA National Aviation Facilities Experimental Center, Atlantic City, N.J. In addition, several FAA airplanes will be equipped to receive the signals sent by beacons.

Runway Outlined

With Microvision, the airborne receivers convert the ground beacon signals into TV-like pictures which appear on a screen in front of the pilot in the cockpit. The pilot will see the runway outlined by electronic lights, even though the runway itself and the usual ground landing lights are not visible to him.

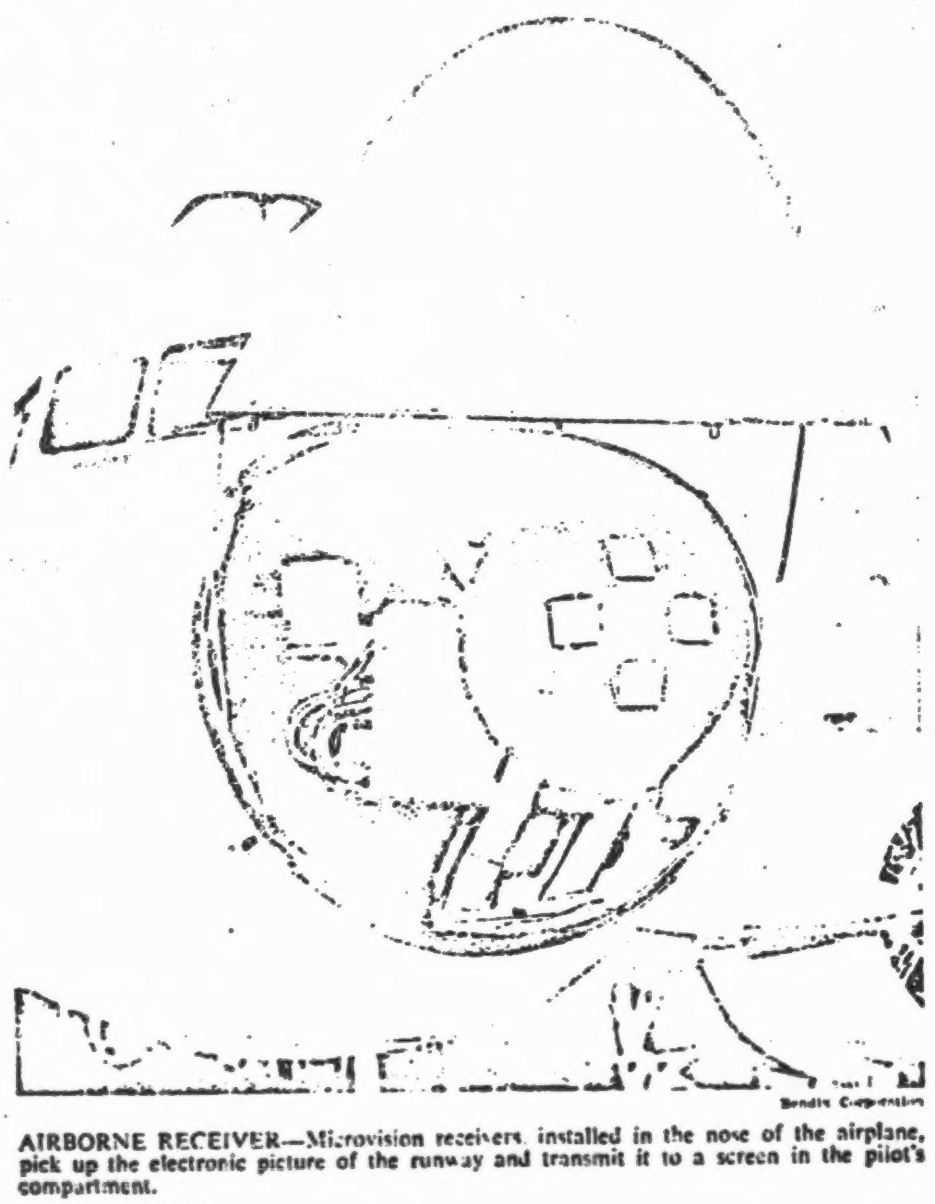
Moreover, the electronic lights may be displayed to outline not only the runway, but also to show the angle at which the aircraft is approaching the runway. Theoretically, the pilot will see almost the same picture he would see during fair weather approaches to lighted runways.

FAA and Bendix officials say that there are many possibilities of combining this microwave beacon with other landing aids to provide maximum safety to bad weather landings.

It was explained that although automatic landing systems make hands off or automatic landings technically feasible, few pilots care to be back-seat drivers to automatic systems and instrument dials during the critical moments just before landing.

A pilot wants to know how well an automatic system is taking him down the approach path, and by visual reference to the ground to decide whether he should take over manual control. Microvision gives him that visual reference. After he first picks up the runway as light patterns from 10 miles out, the runway comes more and more into focus as he gets nearer. A considerable advantage is that the pattern of lights is seen in true perspective.

Microvision consists of three essential elements—ground transmitters, an airborne receiver and a pilot's display. The ground transmitters are placed along each side of a runway in a pattern similar to conventional runway lights, and transmit pulses to the airborne receiver. The pulses, which define the angular position of each transmitter relative to the body of the aircraft, are then converted into visual images that form an outline of the runway kept in continuous relationship to the plane's position. This outline is, in turn, projected directly into the pilot's line of vision.



Bendix Corporation

AIRBORNE RECEIVER—Microvision receivers, installed in the nose of the airplane, pick up the electronic picture of the runway and transmit it to a screen in the pilot's compartment.

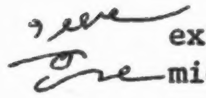
Addendum No. 2 Technical material which was put on IBM belts for practice in writing shorthand

Most of the copy from the textbook was put on IBM belts for practice at progressive speeds.

Supplementary material, for additional practice by advanced students, was put on the IBM belts. This was material similar to that displayed in Addendum No. 1. Along with each belt, there was a correct transcript with previews of difficult technical words.

VENUS' HEAT IS LETHAL

Science News Letter March 26, 1966

	lethal	causing death; deadly; fatal
	centigrade	graduated into a hundred divisions or equal parts; on the centigrade thermometer the freezing point of water is zero and its boiling point 100°
	extraterrestrial microorganism	an extremely small plant or animal organism originating or existing outside the earth or its atmosphere
	toxin	a poison formed as a specific secretion product in the metabolism of a vegetable or animal organism
	oncology oncolytic	study of tumors; science of tumors

Fears that the crash of the Soviet Venus 3 might damage life on Venus are unfounded in the opinion[1] of at least one space medicine authority.

Dr. Generales, chairman of the New York State Medical[2] Society's section on space medicine, said that it is "inconceivable" to him that earth germs could[3] contaminate a planet with the estimated heat of Venus.

"With Mars you have a different situation"[4] said Dr. Generales, "but if the estimated temperature of Venus is 800 degrees Centigrade,[5] the heat would break up proteins."

Sterilizing instruments on earth is done at no more than 250 degrees[6] Centigrade, he pointed out, and said he could not "get excited" about sterilizing hardware to protect Venus.[7]

Dr. Generales coined a Greek-derived word, "kenoplane," to describe astronauts moving around in space. If they[8] kenoplane to the moon and land there, he cannot conceive of serious contamination, and he does not approve[9] of using taxpayers' money to sterilize everything connected with the flight.

TWO INSTANT AIRSTRIPS: FIBER GLASS, ALUMINUM

Science News Letter June 4, 1966

aluminum	a bluish silver-white metal, noted for its lightness and resistance to oxidation
fiber glass	textile fibers and yarns produced from glass, which when drawn fine enough, can be woven into a strong, flexible fabric
helicopter	a form of aircraft whose support in the air is derived solely from the reaction of a stream of air driven downwards by propellers revolving around a verticle axis
buoyant	having the quality of rising or floating in a fluid
polyester resin	a product of chemical synthesis which is very tough and which is heat resistant to 400° F

Two new "instant" airstrips--an aluminum one that floats on rice paddies and one made of fiber glass that can be[1] sprayed on bare ground from a helicopter--are being developed for the U. S. Navy and Air Force.

The Navy's[2] version, made in eight-by-three foot sections, consists of aluminum sandwiches filled with buoyant blocks of plastic[3] foam. A 13,000-pound UE-34D helicopter has already landed on the floating mat[4] in tests at the U. S. Army Waterways Experiment Station, Vicksburg, Mississippi.

The helicopter[5] produced landing forces of up to 26,000 pounds and taxied to within two feet of the mat's edge without[6] damaging the mat or causing it to dip dangerously. Field tests in Viet Nam are scheduled soon. The Aluminum[7] Company of America, manufacturer of the mat, claims a two-year life-span on either water or[8] marshy surfaces.

For use on land, the Air Force is testing a mixture of fiber glass and polyester resin[9] which is ready for use an hour after being sprayed from a tank aboard a hovering helicopter.

NEW LASER CAN FIND "LOST" TARGETS
Science News Letter June 25, 1966

laser	word formed from light amplification through stimulated emission of radiation; a device which makes possible the use of light waves for communication in outer space
coherent	logically consistent; composed of interdependent or related parts
radar	an electronic locating device which instantaneously detects the presence and indicates the position of aircraft, ships, etc., by the use of high frequency radio waves
extraneous	originated or coming from without; not essential
gantries	frame structures, raised on side supports so as to span over something and usually of large dimensions
component	a necessary part

deflector	that which causes to turn aside; to divert from a course or end

The first electrically scanned laser system that also is more precise than radar in tracking rockets during[1] launch periods has been developed.

The unit, which uses a highly concentrated light beam to locate and[2] track its target, is the first laser system capable of relocating a rocket momentarily "lost"[3] in a cloud bank. Laser tracking systems that are scanned mechanically cannot be moved rapidly enough to[4] relocate a speeding target once the target has been lost. In its present stage of development, the system[5] can pinpoint, within 12 inches, the exact location of a rapidly moving object up to a height of[6] eight miles.

The system, being built by Sylvania Electric Products Inc., for the National[7] Aeronautics and Space Administration, is expected to be tested at Cape Kennedy, Florida, next[8] year during a Saturn V launch.

Addendum No. 3 Typing from Rough-draft Copy

Material for this unit of work was collected from scientific offices in the Boulder-Denver area. Whenever it was possible to collect succeeding drafts of the typing and a copy of the final manuscript, this was done so that the students could understand all of the steps in the process. Also, the final copy from the office was used for comparison and correction of student work.

ATTAINABLE SETS IN FINITE AND INFINITE DIMENSIONS

H. Hermes *

~~INTRODUCTION~~

Introduction.

Much of the mathematical theory of optimal control deals with a system of differential equations

$$\dot{x}(t) = f(t, x(t), u(t)) \quad , \quad x(0) = x^0 \qquad (1)$$

where the function $u : [0,T] \to E^r$ (E^r denoting Euclidean r dimensional space), termed the control, may be chosen from a control set $\Omega \subset \mathcal{L}_\infty[0,T]$. (If we say that a vector valued function is in $\mathcal{L}_p[0,T]$ we shall mean that each of its components is in this space.) If we assume conditions on f such that for a choice $u \in \Omega$ a unique solution $x(\cdot, u)$ of (1) exists, the set of derivatives of solutions, ie. the set

$$\mathcal{F} = \{ f(\cdot, x(\cdot, u), u(\cdot)) : u \in \Omega \} \qquad (2)$$

may usually be considered in some Lebesgue space. The attainable set $\mathcal{A}(t)$, for some $t \in [0,T]$, is defined as the set of points attainable at time t by solutions of (1) for all possible choices of control $u \in \Omega$, ie.

$$\mathcal{A}(t) = \{ x^0 + \int_0^t z(\tau) d\tau \; : \; z \in \mathcal{F} \} . \qquad (3)$$

The existence theorems which depend on the compactness of $\mathcal{A}(t)$ may then be viewed as follows: Under what conditions on $\mathcal{F}$ ~~[illegible]~~ will its image

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* This research was supported, in part, by the National Aeronautics and Space Administration under Contract No. NAS8-11264

* Department of Mathematics, Univ. of Colorado.

in E^n under the linear operator L defined by $Lz = \int_0^t z(\tau)d\tau$ be compact? We shall show, for instance, that the Filippov existence theorem [1] can be interpreted as stating that, with his assumptions, $\mathcal{F}$ is a weak * compact subset of $\mathcal{L}_\infty[0,t]$ hence its image under the weak * continuous map L is compact.

While the most natural situation to obtain $\mathcal{C}(t)$ compact would be to seek a topological space in which $\mathcal{F}$ is compact and L continuous, the fact that in general $\mathcal{F}$ will be a subset of an infinite dimensional space while L has finite dimensional range suggests the possibility that even if $\mathcal{F}$ is not compact in its chosen space, the range of $\mathcal{F}$ under L may be compact. In particular, this situation is illustrated by the theorem of A. Lyapunov on the range of a vector measure. Specifically, let $\mathcal{F}$ be that subset of $\mathcal{L}_\infty[0,T]$ such that $z \in \mathcal{F}$ implies $z_i(t)$ is either zero or one for all $t \in [0,T]$, $i = 1, 2, ---, n$. Since $\mathcal{F}$ is not convex, it certainly is not weak * compact nor is it compact in the norm topology of $\mathcal{L}_\infty[0,T]$, yet the Lyapunov theorem yields the fact that its image under L is compact and convex in E^n. This has been used to ~~show~~ obtain existence theorems for linear systems, see [2], [3].

There have been many recent generalizations of Lyapunov's theorem (eg. [4]); it is natural to ask whether it could be applied to a nonlinear system in such a way to yield $\mathcal{T}$ not weak* compact in $\mathcal{L}_\infty[0,T]$ but still so that its image under L is compact (and convex). This question will be pursued.

It should be noted that the use of the Lyapunov theorem in [2], [3] depended on the fact that the control set Ω was defined, as a subset of $\mathcal{L}_\infty[0,T]$, by giving the values which an element $u \in \Omega$ could assume at each $t \in [0,T]$. One might also consider Ω given merely as a subset of $\mathcal{L}_\infty[0,T]$. We shall show, using a construction of Klee, [7], that it is possible for Ω to be a closed, bounded, convex, subset of $\mathcal{L}_\infty[0,T]$ such that the attainable set $\mathcal{A}(T)$ for a linear system ~~of the form~~

$$\dot{x}(t) = A(t)x(t) + B(t)u(t) \quad , \quad x(0) = x^0$$

with the components of A, B in $\mathcal{L}_1[0,T]$, is not closed.

We shall also discuss possible infinite dimensional analogues of the Lyapunov theorem.

§1. STATEMENT OF RESULTS

The control set Ω will be assumed to be given in ~~[illegible]~~ either of the ~~[illegible]~~ two following ways:

(i) For each $t \in [0,T]$ let $U(t)$ be any subset of E^r and $\Omega = \{ u \in \mathcal{L}_\infty[0,T] : u(t) \in U(t) \}$. We assume the sets $U(t)$ are contained in some fixed bounded sphere S in E^r for $t \in [0,T]$.

(ii) Ω is a bounded subset of r vector valued functions with components in $\mathcal{L}_\infty[0,T]$. (Again we assume the values of elements of Ω are contained in S.)

There will be a need to consider $\mathcal{L}_\infty$ with its norm topology, its weak topology, and its weak $*$ topology (or $\mathcal{L}_1$ topology of $\mathcal{L}_\infty$). For writing ease both notations ~~of~~ for the weak $*$ topology will be used.

The assumptions on f in (1) will be

the following:

f is continuous on $[0,T] \times E^n \times S$ and once continuously differentiable in the x argument, unless explicitly stated elsewise (5)

There exists a constant $c > 0$ such that $x \cdot f(t,x,u) \leq c\,[1 + |x|^2]$ for all t, x, u in the domain of definition of f. (This prevents finite escape time!) (6)

With these assumptions, for each $u \in \Omega$, equation (1) has a unique solution defined on $[0,T]$ which will be denoted $x(\cdot, u)$.

In addition to the sets $\mathcal{F}$ and $\mathcal{A}(t)$ defined in the introduction, we define, for the case Ω having the representation (i), the sets

$$F(t) = \left\{ f(t,a,\sigma) : a \in \mathcal{A}(t), \sigma \in U(t) \right\}$$

and

$$\mathcal{B}(t) = \left\{ x^0 + \int_0^t z(\tau)\,dt : z \text{ measurable, } z(\tau) \in F(\tau) \text{ for } 0 \leq \tau \leq t \right\}.$$

REMARKS.
~~Remarks~~

a) The set $F(t)$ is related to the "local direction cone" $\{f(t,x,\sigma) : \sigma \in U(t)\}$ and will always contain ~~the latter~~ this set since it is the union of such sets taken over all x in the attainable set $\mathcal{A}(t)$. It easily follows that we will always have $\mathcal{A}(t) \subset \mathcal{B}(t)$, one of the things we shall be interested in is when are these sets equal.

b) From the assumptions on f and Ω it follows that $\mathcal{F}$ is a bounded subset of $\mathcal{L}_\infty[0,T]$.

ON THE CLOSURE AND CONVEXITY OF ATTAINABLE SETS IN FINITE AND INFINITE DIMENSIONS

H. Hermes*

Introduction.

Much of the mathematical theory of optimal control deals with a system of differential equations

$$x(t) = f(t,x(t),u(t)) \ , \ x(0) = x^0 \tag{1}$$

where the function u: $[0,T] \rightarrow E^n$ (E^n denoting Euclidean n dimensional space), termed the control, may be chosen from a control set $\Omega \subset \mathcal{L}_\infty[0,T]$ (if we say that a vector valued function is in $\mathcal{L}_p[0,T]$ we shall mean that each of its components is in this space.) If we assume conditions on f such that for a choice $u \in \Omega$ a unique solution $x(\cdot,u)$ of (1) exists, the set of derivatives of solutions, i.e. the set

$$\mathcal{F} = f(\cdot,x(\cdot,u), u(\cdot)) : u \in \Omega \tag{2}$$

may usually be considered in some Lebesgue space. The attainable set $\mathcal{A}(t)$, for some $t \in [0,T]$, is defined as the set of points attainable at time t by solutions of (1) for all possible choices of control $u \in \Omega$, i.e.

$$\mathcal{A}(t) = [x^0 + \int_0^t z(t)dt \ : \ z \in \mathcal{F}]. \tag{3}$$

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*This research was supported, in part, by the National Aeronautics and Space Administration under Contract No. NAS8-11264

*Department of Mathematics, University of Colorado

The existence theorems which depend on the compactness of $\mathcal{A}(t)$ may then be viewed as follows: Under what conditions on $\mathcal{Z}$ will its image in E^n under the linear operator L defined by $Lz = \int_0^t z(t)dt$ be compact? We shall show, for instance, that the Filippov existence theorem [1] can be interpreted as stating that, with his assumptions, $\mathcal{Z}$ is a weak * compact subset of $\mathcal{L}_\infty[0,t]$ hence its image under the weak * continuous map L is compact.

While the most natural situation to obtain $\mathcal{A}(t)$ compact would be to seek a topological space in which $\mathcal{Z}$ is compact and L continuous, the fact that in general $\mathcal{Z}$ will be a subset of an infinite dimensional space while L has finite dimensional range suggests the possibility that even if $\mathcal{Z}$ is not compact in its chosen space, the range of $\mathcal{Z}$ under L may by compact. In particular, this situation is illustrated by the theorem of A. Lyapunov on the range of a vector measure. Specifically, let $\mathcal{Z}$ be that subset of $\mathcal{L}_\infty[0,T]$ such that $z \in \mathcal{Z}$ implies $z_i(t)$ is either zero or one for all $t \in [0,T]$, $i = 1,2, - - n$. Since $\mathcal{Z}$ is not convex, it certainly is not weak * compact nor is it compact in the norm topology of $\mathcal{L}_\infty[0,T]$, yet the Lyapunov theorem yields the fact that its image under L is compact and convex in E^n. This has been used to obtain existence theorems for linear systems, see [2], [3].

There have been many recent generalizations of Lyapunov's theorem (e.g. [4]), it is natural to ask whether it could be applied to a nonlinear system in such a way to yield $\mathcal{F}$ not weak * compact in $\mathcal{L}_\infty[0,T]$ but still so that its image under L is compact (and convex). This question will be pursued.

It should be noted that the use of the Lyaponov theorem in [2], [3] depended on the fact that the control set Ω was defined, as a subset of $\mathcal{L}_\infty[0,T]$, by giving the values which an element $u \in \Omega$ could assume at each $t \in [0,T]$. One might also consider Ω given merely as a subset of $\mathcal{L}_\infty[0,T]$. We shall show, using a construction of Klee, [7], that it is possible for Ω to be a closed, bounded, convex, subset of $\mathcal{L}_\infty[0,T]$ such that the attainable set $\mathcal{A}(t)$ for a linear system

$$x(t) = A(t)x(t) + B(t)\ u(t)\ ,\ x(0) = x^0 \qquad (4)$$

with the components of A, B in $\mathcal{L}_1[0,T]$, is not closed.

We shall also discuss possible infinite dimensional analogous of the Lyapunov theorem.

1. Statement of Results.

The control set Ω will be assumed to be given in either of the two following ways:

(i) For each $t \in [0,T]$ let $U(t)$ be any subset of E^r and $\Omega = \{u \in \mathcal{L}_\infty[0,T] : u(t) \in U(t)\}$. We assume the sets $U(t)$ are contained in some fixed bounded sphere S in E^r for $t \in [0,T]$.

(ii) Ω is a bounded subset of r vector valued functions with components in $\mathcal{L}_\infty[0,T]$. (Again we assume the values of elements of Ω are contained in S.)

There will be a need to consider $\mathcal{L}_\infty$ with its norm topology, its weak topology, and its weak * topology (or $\mathcal{L}_1$ topology of $\mathcal{L}_\infty$). For writing ease both notations for the weak * topology will be used.

The assumption of f in (1) will be the following:

> f is continuous on $[0,T] \times E^n \times S$ and once continuously differentiable in the x argument, unless explicitly stated elsewhere.
>
> There exists a constant $c > 0$ such that $x \cdot f(t,x,u) \leq c[1 + |x|^2]$ for all t,x,u in the domain of definition of f. (This prevents finite escape time.)

With these assumptions, for each $u \in \Omega$, equation (1) has a unique solution difined on $[0,T]$ which will be denoted $x(\cdot,u)$.

In addition to the sets $\mathcal{Z}$ and $\mathcal{A}(t)$ defined in the introduction, we define, for the case Ω having the representation (i), the sets

$$F(t) = f(t,a,\sigma) : a \in \mathcal{A}(t),\ \sigma \in U(t)$$

and

$$B(t) = \{x^0 + \int_0^t z(t)dt : z \text{ measurable, } z(t) \in F(t) \text{ for } 0 \leq t \leq t\}.$$

Remarks.

a) The set F(t) is related to the "local direction cone" $\{f(t,x,\sigma) : \sigma \in U(t)\}$ and will always contain this set since it is the union of such sets taken over all x in the attainable set $\mathcal{A}(t)$. It easily follows that we will always have $\mathcal{A}(t) \subset \mathcal{B}(t)$, one of the things we shall be interested in is when are these sets equal.

b) From the assumptions on f and Ω it follows that $\mathcal{F}$ is a bounded subset of $\mathcal{L}_\infty[0,T]$.

We shall next summarize results. In doing so several theorems from other references will be stated, at times the statements of these may be somewhat different from the form in which they originally appeared. In these cases the verification of the equivalence will be included in §2 where proofs of the results are given.

I. [4, Theorem 1] $\mathcal{B}(t)$ is convex for each $t \in [0,T]$.

II. [4, Theorem 4] If F(t) is closed for each $\tau \in [0,t]$ (our assumptions imply it is bounded) then $\mathcal{B}(t)$ is convex and compact for each $t \in [0,T]$.

III. [1, Theorem 1 and Lemma]. Suppose Ω has the representation (i) with U(t) a nonempty compact subset of E^r for each $t \in [0,T]$ which is continuous in the Hausdorff topology as a function of t. Suppose further that for each t,x, $\{f(t,x,\sigma) : \sigma \in U(t)\}$ is convex. Then F(t) is closed for each $t \in [0,T]$.

June 9, 1958

Composite Power Factor and Equivalent Dielectric Losses

Introduction: The purpose of this analysis is the determination of the temperature rise produced at the conductor of a single conductor cable by the dielectric losses throughout the insulation. In other words, the value of the factor p is determined in the equation:

$$T_{cu} - T_s = DL \times p \times R_i$$

Where T_{cu} is the conductor temperature

T_s is the sheath temperature

DL is the dielectric loss

R_i is the thermal resistance of the insulation between conductor and sheath

Conditions are considered for a dielectric with uniform power factor and with power factors varying in magnitude radially through the insulation.

I. Uniformly Varying Power Factor

If the power factor varies linearly with increasing distance from the conductor according to the equation:

$$\tan \delta_x = A - Bx$$

Where $\tan \delta_x$ is the power factor at the distance x from the center of the cable, and

A and B are constants, then the factor p is given by the equation:

$$p = \frac{1}{\tan\delta \left[\log_e r_n/r_a\right]^2} \int_{x=r_a}^{x=r_n} \left[\frac{A\,dx}{x} - B\,dx\right]\left[\log_e r_n - \log_e x\right]$$

The definition of the terms and the derivation of this equation is given in the appendix. The solution of this equation is:

$$p = \frac{1}{\tan\delta \left[\log_e r_n/r_a\right]^2} \left[\frac{A}{2} \log_e r_n^{\,2} - A \log_e r_n \log_e r_a\right.$$

$$\left. + Br_a \log_e r_n + \frac{A}{2}\left[\log_e r_a\right]^2 - Br_a \log_e r_a - Br_n + Br_a\right]$$

$$\text{Where} \quad \tan\delta = \frac{1}{\left[\log_e r_n/r_a\right]} \left[A \log_e r_n/r_a - Br_n + Br_a\right]$$

The results of applying this formula to a 345 kv single conductor cable with a conductor cable with a conductor diameter of 1.83 inches and an insulation thickness of 1 inch are shown in the table below:

Power Factor - %					
at conductor	0.6	0.6	1.2	2.0	10.0
at sheath	0.4	0.2	0.4	0.4	0.4
composite	0.51	0.43	0.85	1.31	5.78
Factor p	0.53	0.58	0.58	0.60	0.64

The factor p increases as the range in power factor between conductor and sheath increases.

II. Constant Power Factor

If the power factor is constant throughout the insulation, then the factor B becomes zero and the factor A becomes equal to $\tan\delta$. Then the equation for p becomes:

$$p = \frac{1}{\left(\log_e r_n/r_a\right)^2 \tan\delta} \times \frac{\tan\delta}{2}\left[\left(\log_e r_n\right)^2 - 2\log_e r_n r_a + \left(\log_e r_a\right)^2\right],$$

or

$$p = \frac{1}{\tan\delta\left(\log_e r_n/r_a\right)^2} \times \frac{\tan\delta}{2}\left(\log_e r_n - \log_e r_a\right)^2$$

which results in $p = \frac{1}{2}$.

III. Irregularly Varying Power Factor

If the power factor varies in an irregular way from conductor to sheath, then the factor p must be determined by a summation method as explained in the appendix. The equation for p is then:

$$p = \frac{1}{\tan\delta\left(\log_e r_n/r_a\right)^2} \sum_{x=r_a}^{x=r_n} \tan\delta_i \left(\log_e \frac{r_i + 1}{r_i}\right)\left(\log_e \frac{r_n}{r_i + \frac{1}{2}}\right)$$

Where

$$\tan\delta = \frac{1}{\log_e r_n/r_a} \sum_{x=r_a}^{x=r_n} \log_e \frac{r_i + 1}{r_i} \tan\delta_i$$

Appendix attached. H. A. Adler

Addendum No. 4 Handwritten copy to be typed.

This material was handwritten by the mathematics teacher and by the science teacher, and it all pertained directly to the work in those classes. Emphasis was placed on correct typing together with understanding of the material being typed.

Please copy the following:

$2KClO_3 \rightarrow 2KCl + 3O_2\uparrow$

$2Na_2O_2 + 2H_2O \rightarrow 4NaOH + O_2\uparrow$

$2H_2O \xrightarrow{\text{electrolysis}} 2H_2 + O_2\uparrow$

$2Hg + O_2 \rightarrow 2HgO$

$2HgO \xrightarrow{\text{heat}} 2Hg + O_2\uparrow$

$2Na + 2HOH \rightarrow 2NaOH + H_2\uparrow$

$CuSO_4 \cdot 5H_2O \rightarrow CuSO_4 + 5H_2O$

$Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow Al(OH)_3\downarrow 3CaSO_4\downarrow$

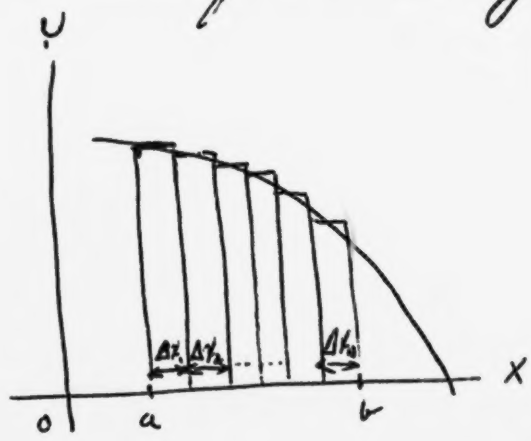
Points to consider:

1. Proper writing & typewritten form of formulas
2. Discuss what balancing is
3. Indicate use of ↓ + ↑ what the symbols are for.

IV. The Integral

We will now consider the inverse operation of differentiation, integration. While differentiation is largely a process of finding the limit of a difference integration is the process of finding the limit of a sum.

Consider the following figure.



Divide the interval from $x=a$ to $x=b$ into n subintervals & erect ordinates at the points. Continue the construction to form n rectangles under the curve. Then the sum of the areas of the rectangles approximates the area under the curve.

Let us assume that some function, $f(x)$, defines the curve & it has a derivative $\phi(x)$.

(a) The length of each subinterval is $\Delta x_1, \Delta x_2, \ldots, \Delta x_n$.

(b) The abscissas of the points in the subinterval are $x_1, x_2, \ldots, x_n$.

(c) The corresponding ordinates are $\phi(x_1), \phi(x_2), \ldots, \phi(x_n)$.

(d) The area of each rectangle then is $\phi(x_1)\Delta x_1, \phi(x_2)\Delta x_2, \ldots, \phi(x_N)$.

(e) Hence the area under the curve is then equal to

$$\lim_{n\to\infty}\left[\phi(x_1)\Delta x_1+\phi(x_2)\Delta x_2+\cdots+\phi(x_N)\Delta x_N\right].$$

We now define the definite integral from this limit as being

$$* \quad \int_a^b \phi(x)\,dx = \lim_{n\to\infty}\sum_{i=1}^{N}\phi(x_i)\Delta x_i .$$

This is the basis of the Fundamental Theorem of Integral Calculus.

Dr. Colin W. Stearn, Dept of Geological Sciences, McGill Univ, Montreal, Quebec,Can

Dear Dr. Stearn:

Thank you for your letter of May 31, ~~which I have just received.~~ Jack Wray and I are ~~both~~ delighted to learn that you may be able to visit ~~mightxbexablextoxaccompany xx are interested in working~~ in the Mount Haultain area in August at the time our party will be there. We would be ~~very~~ pleased to have you accompany ~~our party~~ and have you a member of our field party ~~at no expense to you.~~

Your interest ~~and~~ in ~~the~~ stromatoporoids, particularly in the paleoecologic focus, parallels that of Jack Wray and it might well be mutually advantageous for ~~both~~ the two of you to be in the area together.

Our ~~tentative~~ plans ~~callxfor~~ ~~have us going~~ are to pack into the Mt. Haultain part of the ancient wall ~~area~~ on ~~Wednesday~~ Thursday, August 4, and to pack ~~coming~~ out on ~~Thursday~~ Wednesday, August 10, thereby ~~leaving only~~ having a period of five days for reconnaissance work in the area. It seems likely that much of our time and efforts to focus [illegible] ~~the time and focus~~ will be spent on the southeast side of Mount Haultain at the [illegible] area. ~~but~~ However we had hoped to be able to spend at least one field day in the Cirque area on the northeast side. Jack Wray ~~was speculating as to how it might be possible to~~ hopes to spend more of his time in this latter area. ~~and it is quite possible if this fit your plans that~~ Perhaps the two of you could be working ~~somewhat independently~~ from a temporary camp base in the latter ~~from the remainder of the seven-man field party~~ party for part of the five days.

~~In view of your past experience with the area and the xxx parallelism of interests of you and Dr. Wray,~~ If you ~~can~~ accompany us ~~and devote some of your time with Jack Wray,~~ Marathon would be pleased to pay your field expenses ~~offer you an honorarium equivalent to two days of consulting time, which would amount to $300.00.~~

~~Your letter has been turned over to Dr. Wray and I am sure he will be~~ Dr. Wray will be contacting you regarding ~~further details~~ dates when we learn that the plans outlined in this letter would be satisfactory to you. As I will be in the

Dr. Colin W. Stearn, Dept of Geological Sciences, McGill Univ, Montreal, Quebec, Can

Dear Dr. Stearn:

Thank you for your letter of May 31 which I have just received. Jack Wray and I are ~~both~~ delighted to learn that you ~~might be able to accompany us~~ are interested in working in the Mount Haultain area in August at the time our party will be there. We would be very pleased to have you accompany our party and have you a member of our field party at no expense to you.

Your interest ~~and~~ in the stromatoporoids, particularly the paleoecologic focus, parallels that of Jack Wray and it might well be mutually advantageous for both of you to be in the area together.

Our ~~tentative~~ plans ~~call for~~ have us going into the ancient wall area on Thursday ~~Wednesday~~, August 4, and coming out on ~~Thursda~~ Wednesday, August 10, thereby leaving only a period of five days for reconnaissance work in the area. It seems likely that much of the time and focus will be spent on the southeast side of Mount Haultain but we had hoped to be able to spend at least one field day in the Cirque area on the northeast side. Jack Wray was speculating as to how it might be possible to spend more of his time in this latter area and it is quite possible if this fit your plans that the two of you would be working somewhat independently from the remainder of the seven-man field party.

In view of your past experience with the area and the ~~xxx~~ parallelism of interests of you and Dr. Wray, if you can accompany us and devote some of your time with Jack Wray, Marathon would be pleased to offer you an honorarium equivalent to two days of consulting time, which would amount to $300.00.

Your letter has been turned over to Dr. Wray and I am sure he will be contacting you regarding further details when we learn that the plans outlined in this letter would be satisfactory to you. As I will be in the field for the next three weeks, any further correspondence should be with Jack Wray ~~rather than with me~~.

We do hope you will find it possible to accompany us.

VTY, LCP

Cc: A. B. MacKenzie
~~cc: Jack Wray?~~
J. L. Wray
Gordon [illegible]

MARATHON OIL COMPANY DENVER RESEARCH CENTER

LITTLETON, COLORADO 80121

June 20, 1966

Dr. Colin W. Stearn
Department of Geological Sciences
McGill University
Montreal, Quebec

Dear Dr. Stearn:

Thank you for your letter of May 31. Jack Wray and I are delighted to learn that you may be able to be in the Mount Haultain area in August at the time our party will be there. Your interest in stromatoporoids, particularly in the paleoecologic focus, parallels that of Jack Wray and it might well be mutually advantageous for the two of you to be in the area together. We would be pleased to have you accompany us and have you a member of our field party.

Our plans are to pack into the Mount Haultain part of the Ancient Wall complex on Thursday, August 4, and to pack out on Wednesday, August 10, thereby having a period of five days for reconnaissance work in the area. It seems likely that much of my time and of most of our seven geologists will be spent on the southeast side of Mount Haultain at the basin-to-bank transition area. However, we had hoped to be able to spend at least one field day in the cirque area on the northeast side. Jack Wray hopes to spend more of his time in this latter area. Perhaps the two of you could be working from a temporary camp base in that area for part of the five days.

If you do accompany us, Marathon would be pleased to pay your field expenses. Dr. Wray will be contacting you later when we learn that the plans and dates outlined in this letter would be satisfactory to you. As I will be in the field for the next three weeks, any further correspondence should be with Jack Wray.

We do hope you will find it possible to accompany us.

Very truly yours,

Lloyd C. Pray

LCP:ls
cc: D. B. MacKenzie
Gordon Pringle
J. L. Wray

Addendum No. 5 Related learning study guides and quizzes.

These study guides and quizzes covered material presented in shorthand dictation. Their purpose was to help in understanding scientific terminology and symbols, and to reinforce the learning in the mathematics and science classes.

Study Guide. Hydrocarbons and Petro-chemicals.

1. Hydrocarbons are derived from _______________, _______________ and _______________ gas.

2. Heat is released when hydrogen and carbon are combined with _______________.

3. Most petroleum is used for fuel and energy. Only about _____ percent of the crude oil which is refined is used to make chemicals. This small percentage of crude oil, however, produces approximately _____ percent of the organic chemicals manufactured in the United States. These chemicals are called _______________.

4. Among the products which are created by the chemical transformation of crude oil are _______________, _______________, _______________, _______________, _______________, _______________, and _______________.

5. A necessary part of this chemical transformation of crude oil is the _______________ which is defined as anything that affects a chemical change without itself being affected.

6. There are more than _____ different kinds of catalysts recorded in the library of the ESSO Research Laboratories.

7. "Cracking" is the most important process for changing the structure of hydrocarbon molecules. _____________ cracking is brought about by raising the complex hydrocarbon molecules to very high temperature under increased pressure.

8. Important end products of the petro-chemical industry are fibers such as ______________ and _______________.

9. Petroleum solvents are gaining increasing importance. The two main types are the ______________ and the _______________.

10. Briefly summarize how the computer at ESSO Research Laboratories in Florham Park, New Jersey, is being used to help the petrochemical industry in its search for new fuels for the space age.

December 3, 1966

PART I Identify:

κ ________ ε ________

β ________ η ________

γ ________ ι ________

α ________ ζ ________

δ ________ θ ________

PART II Match the words with the definitions:

aliphatics
alkali
aniline
aromatics
atom
catalyst
resins
toxicity

chloride
detergent
diluent
distillation
hydrocarbons
hydrogen
solvent
thermodynamics

hydrogenation
isomer
molecule
monomer
nitrogen
oxide
synthetic

paraffin
petrochemicals
polymerization
propellant
propylene
radical
tertiary

__________1. A substance that by its presence aids in producing or accelerating chemical action without itself being changed.

__________2. Open chain carbon compounds.

__________3. The science that deals with the relationship of heat and mechanical energy and the conversion of one into the other.

__________4. The process of heating a substance to the temperature at which it is converted to a vapor and then cooling the vapor, thus restoring it to a liquid condition.

__________5. The smallest particle of an element that retains all physical and chemical properties of the element and enters into composition of molecules.

__________6. Organic substances from plants and trees or ones prepared synthetically. They are characterized by lack of crystalline structure, low melting point, insolubility in water, solubility in alcohols, and in most organic solvents.

__________7. A particle of matter resulting from the chemical combination of two or more like or unlike atoms.

__________8. Hydrocarbon compounds characterized by the presence of benzane, usually odorous.

__________9. Man-made; not occurring naturally.

__________10. Chemicals of petroleum origin.

__________11. A substance used for dissolving another substance.

__________12. A substance whose molecules are made of the same number of the same atoms as another substance, but the atoms are differently arranged.

__________13. A colorless, tasteless, odorless element forming nearly four-fifths of the atmosphere.

__________14. A liquid used to thin out another liquid.

__________15. A fuel or explosive used to push or drive forward.

__________16. A cleansing substance.

__________17. The lightest of all gases, occurring chiefly in combination with oxygen in water; also in acid bases, alcohols, petroleum, and other hydrocarbons.

__________18. Compounds containing only hydrogen and carbon.

__________19. The state, quality, or degree of being poisonous.

__________20. The process of adding hydrogen to the unsaturated hydrocarbon molecule.

__________21. The simple unpolymerized form of a compound as distinguished from a polymer.

__________22. The process of joining two or more like molecules to form a more complex molecule. It is of importance in the production of motor fuel and aviation fuel components from cracked gases, and in synthetics.

__________23. A compound in which chorine is combined with another element or radical.

__________24. A compound composed of oxygen and an element or a radical.

__________25. Any substance having marked basic properties. It is applied to hydroxides of ammonium, lithium, potassium, and sodium which are soluable in water and have the power of neutralizing acids and forming salts with them.

__________26. A gaseous olefinic hydrocarbon produced during cracking. It is used to make polypropylenes, plasticizers, etc.

__________27. A colorless, poisonour, oily liquid used in making dyes.

__________28. A white waxy solid substance consisting of a mixture of hydrocarbons, obtained from distillation of petroleum.

__________29. Of third order, involving the substitution of three atoms or radicals.

__________30. Atom or group of atoms behaving as a unit in a chemical reaction.

January 28, 1967

PART I Identify:

ρ __________
σ __________
α __________
ι __________
θ __________
ω __________
π __________
λ __________
ψ __________
ϕ __________
χ __________
ν __________
δ __________
τ __________
κ __________

PART II Match the words and the definitions:

-amide
amino
calender
caprolactam
casein
calcium
cellulose
condensation
dimethyl
elastomers
flexural
iso-
malleable
macro-
micron
monofilament
nitrate
-ol
orifices
plasticizers
plastisols
polyamide
polymeric
polyolefin
slag
sucrose
syn-
ultra-
veneers
volatiles

__________1. Chief substance of the woody part of plants, used in the manufacture of paper, rayon, explosives, etc.

__________2. Substances added to a mixture to keep it soft and pliable. Used widely in the plastics, lacquer, and synthetic fabric industries

__________3. Conversion to a more concentrated or compact form. The process is usually not reversible.

__________4. A derivative of ammonia in which hydrogen atoms have been replaced by radicals containing hydrogen and carbon atoms.

__________5. A compound characterized by more than one amide group, such as nylon.

__________6. A protein occurring in milk and used in thermosetting materials such as insulators, handles, buttons, etc.

__________7. Single, untwisted synthetic thread or fiber made for use in textiles, hosiery, screens, fishing lines, etc.

__________8. An olefin containing many double bonds.

__________9. A molecule containing two methyl groups.

__________10. Of, relating to, or resulting from bending or folding.

__________11. Water-soluble, crystalline sugar.

__________12. A white, crystalline amide used chiefly in making one kind of nylon.

__________13. Any substances, especially synthetic polmers, having properties of natural, reclaimed, vulcanized, or synthetic rubber.

__________14. A unit of length equal to one millionth of a meter.

__________15. Small openings intended for the passage of a fluid.

__________16. The material which separates from the molten metal during the smelting of ores.

__________17. With, together; at the same time; denoting isomers of double-bonded compounds having like atoms or groups on the same side of the bond. In the last sence, usually italicized and hyphenated.

__________18. Alcohols and phenols are given the name of the hydrocarbon from which they are derived followed by this suffix; also may represent a chemical compound containing hydroxyl.

__________19. A soft, silver-white metallic chemical element found in limestone, marble, chalk, etc., always in combination.

__________20. Large, thick; excessively developed; involving large quantities.

__________21. A salt or ester of nitric acid which is readily soluble in water and decomposes when heated.

__________22. A machine with rollers between which paper or cloth is run to give it a smooth or glossy finish.

__________23. Denoting a class of compounds derived from ammonia.

__________24. Capable of being hammered, pounded, or pressed into various shapes without breaking or returning to the original shape.

__________25. Powdered thermoplastic resins; in a liquid plasticizer used chiefly in coatings, films, and molded products.

__________26. Substances having low loiling temperatures at ordinary pressure.

__________27. Thin layers of fine material, usually wood, glued to less expensive material.

__________28. Consisting of the same elements in the same proportion by weight but differing in molecular weight.

__________29. Equal; alike; usually denoting an isomer of a compound.

__________30. Beyond in space; beyond the limits of; on the other side; excessively.

1. A sour, colorless liquid compound having a sharp odor, found in vinegar. __________

2. Of the nature of or like water. __________

3. Organic compounds composed of carbon, hydrogen, and oxygen, including the sugars, starches, and celluloses. ____________

4. Of, relating to, or produced by an enzyme. ____________

5. Severe suffering, punishments or afflictions. ____________

6. Pertaining to a white, crystalline compound, prepared from phenol and used as a food preservative and mild antiseptic. ____________

7. A condensed product of distillation. ____________

8. White, crystalline, aromatic hydrocarbon from coal tar, used as a disinfectant, and in the manufacture of dyes and explosives. ____________

9. Consisting of or containing cells. ____________

10. Fungi bearing chains of black spores attached to stalks on the swollen end of a threadlike branch. ____________

11. A crystalline acid that readily dehydrates and is used chiefly in cleaning metals. ____________

12. A powerful antibiotic used in the treatment and prevention of some infections due to its ability to stop growth of certain bacteria. ____________

13. Concerning drugs or pharmacy. ____________

14. Of or containing mercury. ____________

15. An antibiotic drug derived from an earth, effective against certain viruses as well as against bacteria. ____________

16. A yellow crystalline antibiotic. ____________

17. An antibiotic. ____________

18. Actions of two or more agents or organs cooperating with each other to increase the effectiveness of one or both. ____________________

19. An antibiotic. ____________________

20. A yellow crystalline antibiotic. ____________________

21. A severe form of anemia characterized by a gradual reduction in the number of the red blood cells, general weakness, gastrointestinal and nervous disturbances, etc. ____________________

22. Vitamin B complex found in milk, eggs, liver, kidney, grass, fruits, etc. Lack of it in the diet causes stunted growth, loss of hair, etc. ____________________

23. A member of the vitamin B_6 group. ____________________

24. A complex white, crystalline compound found in the outer coating of cereal grains, green peas, beans, egg yolk, etc. A deficiency of this will result in certain nervous disorders. ____________________

25. Serving to cure or heal. ____________________

26. An excess of red blood cells. ____________________

27. A colorless crystalline compound which is the active hormone of the thyroid gland. ____________________

28. Movement of bacteria or cancerous cells from one part of the body to the other. ____________________

29. In, into, or within a vein or veins. ____________________

30. Pain and oppression about the heart. ____________________

31. Agents that isolate or separate. ____________________

32. Salts or esters of propionic acid used for fruity and floral odors in perfumes, etc. ____________________

33. Cellular organisms that live on organic matter. ____________________

34. Pertaining to health and its preservation. ____________________

35. Moistening agent. ____________________

36. A crystalline insecticide said to be faster acting and less toxic to warm-blooded animals than DDT. ____________________

37. One of two oily liquid esters having insecticidal properties. ____________________

38. A remedy that stimulates the action of another. ____________________

39. Substances which destroy bacteria or fungi. ____________________

40. Agents used to destroy or inhibit plant growth. ____________________

41. Pertaining to the heart and blood vessels. ____________________

42. The first part of the small intestine. ____________________

43. Any of several drugs used to minimize the action of histamine in certain allergic conditions. ____________________

44. A tracing showing the changes in electric potential produced by the brain. ____________________

45. A salt used as a diuretic and to increase flow of bile from the liver. ____________________

46. A conclusion drawn before all the facts are established. ____________________

47. Any of the various nucleic acids that on hydrolysis yield deoxyribose, commonly obtained from the thymus gland. ____________________

48. Any of the various nucleic acids that yield ribose as one product. Obtained from yeasts. ________________

49. Obtained by hydrolysis of DNA. ________________

50. Pertaining to heredity and its variations. ________________

- - - - - - - - - - - - - - -

GENERAL DISCUSSION:

Which of the subject areas in the unit on LIFE SCIENCES contributed the most toward your general knowledge and understanding of this particular branch of science? Explain.

APPENDIX U

Scientific Secretary Training Development Program

Curriculum Guide

for

English

I. Course objectives

A. To develop critical attitudes towards careless writing wherever it may occur.

B. To develop library research skills in locating articles in all scientific journals through use of the proper indices and other sources of information.

C. To develop skills in summarizing information.

D. To develop skills in editing and re-writing.

II. Instructional materials

A. Published materials:

No single textbook was found to be satisfactory for use in the course. However, the following reading references were used:

1. William Strunk, Jr. and E. B. White.
The Elements of Style
New York: MacMillan Paperbacks, 1959

2. Porter G. Perrin.
Writer's Guide and Index to English
Chicago: Scott, Foresman and Co., 1959

3. Harry Shaw.
Errors in English and Ways to Correct Them
New York: Baines and Noble, 1962

4. R. H. Copperud.
A Dictionary of Usage and Style
New York: Hawthorne Books, 1964

5. Henry W. Fowler.
   Modern English Usage
   Oxford University Press, 1937

B. Unpublished materials prepared by the teachers:

1. Before classes were scheduled the teacher had collected over two hundred items illustrating common errors in grammar and usage:

   (1) Many from newspapers.
   (2) Examples from best selling books.
   (3) Examples from television.
   (4) Examples from technical and scientific journals.

   (Please see Addendum No. 1 and Sections 2 and 3 of Addendum No. 4 for examples of such items.)

2. Compilation of materials for oral drills illustrating common errors. (Please see Addendum No. 2)

3. Compilation of review quizzes, objective in type. (Addendum No. 3 gives sample quizzes)

4. Compilation of challenging problems in re-writing. (Addendum No. 4)

III. Methods of instruction

A. Lecture and discussion sessions based on teacher prepared materials. (Addendum No. 1 gives examples)

B. Discussions based upon certain differences of opinion among recognized authorities. (Using this type of material is valuable for illustration of weaknesses in such "rules" as: Never split an infinitive. Never end a sentence with a preposition.)

C. Oral drills. (Addendum No. 2)

D. Review quizzes, objective in type. (Addendum No. 3)

E. Exercises in re-writing examples of poor sentence structure. (Addendum No. 4)

F. Library research. (Please see Unit 10 in Units of Instruction)

G. Discussion of materials contributed by members of the class to illustrate errors they discovered in letters house organs, newspapers, and other sources.

IV. Units of Instruction

Although the following units may be used as a general guide to materials which should be given special emphasis, it is most important that the teacher be able to recognize errors wherever they occur and to answer questions about them. A total of thirty-two hours of instruction, scheduled on a basis of one hour per week for thirty-two weeks, constituted the in-class time allocation for the following units of instruction:

Unit 1. Verbs.

(a) Misuse of irregular verbs.
(b) Overworked verbs such as "get".
(c) Agreement of verbs with compound subject.

Unit 2. Pronouns.

(a) Agreement of pronouns with antecedents.
(b) Number and case of pronouns.
(c) Relative pronouns.
(d) Identification of "danglers."

Unit 3. Collective nouns.

(a) Correct use of verbs following collective nouns.
(b) Correct use of pronouns following collective nouns.

Unit 4. Adverbs and adjectives.

(a) Special attention to words used as either adjectives or adverbs.
(b) Overworked adverbs and adjectives--how to avoid.
(c) When adjectives follow verbs as in "sounds good" and "tastes good."

Unit 5. Prepositions and connectives frequently misused.

Examples:

than - from
among - between
less - fewer
like - as
in - into
outside of - in addition to
nevertheless - however
on - onto
farther - further

Unit 6. Vocabulary - pronunciation and spelling.

(a) Words that are often confused, such as allusion, illusion.
(b) Words that should never be used such as "irregardless", "folks", "enthused".
(c) Words most frequently misspelled.
(d) Words most frequently mispronounced.

Unit 7. Punctuation.

(a) Elimination of misplaced or unnecessary commas.
(b) Correct use of quotation marks.
(c) Commas versus semicolons.

Unit 8. Study of comparisons.

Examples:

good - better - best
more rapidly - most rapidly
more solid - not solider
as ---- as
not so ---- as

Unit 9. Rewriting exercises.

(a) Special attention to redundancies.
(b) Avoiding strings of substantives.
(c) Correction of "danglers" and other common errors.

Unit 10. Library research.

(Topics assigned were in all instances related to material studied in the Science class.)

Examples of topics:

(a) A reference to a quaternary ammonium compound.
(b) Lanthanide chemistry.
(c) Photolysis in photosynthesis.
(d) Utilization of the laser in electronic research.
(e) Epoxies and space research.
(f) A paper on "Continental Drift," published in 1963..

Addendum No. 1. English Curriculum Guide (sample exercises)

Materials to discuss and correct

Examples of newspaper items:

(1) If ten million starved, there were ten million less mouths to feed.
(2) They want to expand the program so that within three years every student is receiving the same type of training.
(3) Everyone wants to talk about their experiences.
(4) "It was like we weren't going to make it," he said.
(5) We should check the resort of violence against South Vietnam.
(6) Everyone loved the angels since their arrival.
(7) Officials say bacteria find no cause for alarm. (Headline)
(8) We know to use the correct form of the verb.
(9) Education is the acquisition of the art of the utilization of knowledge.
(10) She stimulated my interest towards a conversation.
(11) The public is invited to this meeting when tea will be served.
(12) Those wishing to hear the address but don't hold tickets will be admitted at 9:45 a.m.
(13) The war is injustified and undisputably phony.
(14) They made plain they would no longer feel restrained.
(15) Things were running well in the things that were important.
(16) None of them are perfect.
(17) This is anti-social behavior that people under eighteen do.
(18) It is imperative that Republicans are elected.
(19) Both the Nationalist sentiments and those who represented the Eastern border are represented.
(20) They were civilians who must be terrorized into obedience who were the victims.

Examples from scientific journals:

(1) The Bill would provide for an effort to push food aid to the limits of specific action and specifically would lend strong support to expanding receiving countries absorptive capacity now so woefully limited by inadequate port facilities.

(2) A provisional age of Cretaceous-Tertiary was assigned to the formation by these workers based upon stratigraphic relationships.

(3) It seems apparent then, that the detrimental effects of oil consumption are -------

(4) This is a central issue in the biological controversy of Mars.

(5) None of the stems of either Salix petiolaris or Cornus stolonifeser aged in the field by actual ring count were more than twelve years old.

(6) A great amount of experimental data have been accumulated.

(7) Not only does it reduce light and increase safety hazards but, it is totally uneconomic.

(8) All articles of glassware were thoroughly rinsed in water which has been doubly distilled.

(9) They may be a very key element.

(10) The third type of receptor ending I found only in phoxinus, and appears to be unlike any olfactory structure that has been described before in vertebrates.

Addendum No. 2. English Curriculum Guide

(examples of oral drills)

1. The store is (adjacent to) (adjoining) the elementary school.

2. They (admit) (admit to) acts of vandalism.

3. They (confess) (confess to) the failure of their plans.

4. She is teaching (advance) (advanced) Spanish classes.

5. Many persons were (affected) (effected) by the strike.

6. Can you (affect) (effect) a change in your attitude?

7. A merger was (effected)(affected) between the two companies.

8. He was charged with (alleged arson) (arson).

9. The witness was indicted for (alleged perjury) (perjury).

10. They told us that it was (all right) (alright) to swim here.

11. They went (all together) (altogether) on one bus.

12. That notion is (all together) (altogether) useless.

13. It was the largest registration (ever to be) (ever) recorded at C. U.

14. He was one of three speakers (to address) (who addressed) the meeting.

15. I (am to meet) (will meet) the 5:15.

16. In which sentence is the split infinitive excusable,- and even preferable? Why?
    (a) I want to thoroughly examine the problem.
    (b) This will allow us to quietly drop the dispute.

17. Until recently a student at C. U., Mary's real ambition was to be an actress. (This is a dangler. Why?)

18. She thought the performance as good or better than last year's. (Supply the needed word.)

19. Which of the following are correct, which incorrect?
    (1) He ate like a pig.
    (2) They cannot spell like children used to spell.

(3) They went to the park like they said they would.
(4) The helicopter, like the horseless carriage, is here to stay.
(5) She trembled like a leaf.
(6) The scientist, like any other citizen, has a right to vote.
(7) I did the work like you told me to.
(8) They did not act like I thought they would.
(9) She sounded like she thought I was crazy.
(10) I think she looks like her sister.

20. Give examples to illustrate the use of average, median, and mean.

21. Complete by using the correct form of lie or lay:
(1) The hen......an egg.
(2) I laid the book on the desk where it had been......ing before.
(3) I shall......down for an hour.
(4) I......in bed wide awake all last night.
(5) How long have you......there waiting for help?
(6) ......that gun down!
(7) Her books had......on the ground all night.
(8) Had the children......their overshoes in a row?
(9) Have you been......ing here in the dark?
(10) What are those bundles you are......ing on the bench?

What changes are needed in these?:

1. His attitude makes me mad.

2. I will pay your bill if you will accept my check.

3. The reason I'm worried is because I think she's ill.

4. His work is different than mine.

5. Can I have another helping of potatoes?

6. I encountered less difficulties than I had expected.

7. Everyone put on their coats and went home.

8. How much money have you got?

9. Due to the storm, all trains are late.

10. She has an awful headache.

11. We only have five left.

12. Let's not walk any further right now.

13. I shall not continue this discussion farther.

14. We must remember to accurately check each answer.

15. Why don't you write like I do?

16. Go slow when you pass the school.

17. It is me who sent that letter.

18. She acts as if she was my wife.

19. Who did you meet at the party?

20. He's not doing his work like I told him to.

21. He acts more like you and I every day.

22. None of the houses are cheap enough.

23. She is having difficulty choosing among those two dresses.

24. I had a hard time deciding between all those hats.

25. I'm sorry, but I am disinterested in their problems.

26. The reason she is fat is because she overeats.

27. I think that is a phenomena.

28. Due to a bad cold, he stayed home.

29. Lying in the store window, she fell in love with that ring.

30. Please try and come early.

31. She cannot cook like mother could.

32. She is much older than me.

33. I shall go there, irregardless of the consequences.

These sentences illustrate misuse of prepositions. How should they be changed?

1. I'll wait on you at my house at seven o'clock.

2. He lives by me.

3. The secret to making this a success is hard work.

4. Teachers must learn ways in working with kids.

5. Can I convince you to work harder?

6. Does he brag on his achievements?

7. He ran in the house to see his mother.

8. I had to choose between the three books.

9. The workmen put another row of bricks onto the wall.

10. Where will you be at?

11. We were to Denver last Saturday.

A. Write in the blank space in each sentence the correct form of lie or lay:

1. Mother has seldom had a chance to......in bed late.

2. Although the house was filled with visitors, Mary still... ...in bed.

3. While we were searching for him, Jimmy was......in the hay, fast asleep.

4. I have seldom......in bed after the alarm clock has gone off.

5. When he was told to do so, our dog always......down.

6. She came in and......the wet umbrella on the new carpet.

7. I saw the books......on your desk, right where you had... ...them earlier today.

8. Grandma often said, "Let sleeping dogs......"

9. ......that gun down!

10. For several days the officers......in wait for the burglars.

11. Mary had to......down to rest after her swim.

B. Supply the correct form of sit or set:

1. The old lady has......in that chair all day.

2. Mary has been......there in the bus station for three hours.

3. I asked him to......the packages on the table.

4. Why do you......your plants on the window sill where the cat likes to......?

5. They had been......ing all the dirty dishes on the counter.

6. Will you please......still?

7. Where have you......the place-cards?

C. Supply well or good in each blank space:

1. How......the children read!

2. I don't feel very......today.

3. All those records sound......on your stereo.

4. That dress looks......on you, but I could never wear it.

5. He has a good voice and uses it......in that role.

Addendum No. 3. English Curriculum Guide

(sample review exercises)

1. They addressed the invitation to (him and me) (he and I).

2. Mary wanted to go with (us) (we) girls.

3. (We) (Us) three went to the show together.

4. They provided new texts for (we) (us) students.

5. All members were present except (he) (him) and George.

6. (Who) (Whom) should we report to?

7. (Who) (Whom) were they talking about?

8. (Who) (Whom) did she think the speaker was?

9. (Who) (Whom) did you suppose him to be?

10. This recipe requires less sugar and (less) (fewer) eggs than the old one.

11. I can move (swifter) (more swiftly) if I wear low heels.

12. Please speak (louder) (more loudly).

13. Jane can add sums (easier) (more easily) than I can.

14. Does each of you have (your) (his) ticket?

15. Everybody present was asked to correct (her) (their) own paper.

16. Someone has left (his) (their) car in the driveway.

Rewrite:

17. Bouncing several times, we saw the small plane land.

18. Pouring out clouds of smoke, we followed that heavy truck.

19. The war deprived the population of food which was bad for their health.

20. I paid two dollars for that canary which was too little.

In the blanks use one of the principal parts of the verb used earlier in the same sentence:

1. Today I shall beat the cake mix longer than I have ever ______ it before.

2. They began their work more promptly than they had ______ it before.

3. She will begin her song soon; last night that aria ______ at nine o'clock.

4. Why did that child's balloon burst before any of the others had ______?

5. The class came running because recess had ______ to an end.

6. Do not draw pictures on the wall: those which you have already ______ cannot be erased.

7. The heroine will flee from the castle because the hero has already ______.

8. This river flows rapidly; it has always ______ between high banks at this spot.

9. I like to fly but I have never ______ across an ocean.

10. The boys swim in the swimming hole where their fathers ______ as boys. Children have ______ there for a hundred years.

11. The law in that state permits hanging; early settlers ______ captured outlaws before there were any courts.

12. Please do not ring the bell so loudly; it seems to have ______ in my ears forever.

13. Let me swing on your swing; you have often ______ on mine.

14. Can you write a reply to this letter as concisely as it was ____?

15. I think the lake will freeze tonight, although it has not _____ previously this winter.

16. If a criminal steals jewelry he may have trouble disposing of the articles which he has ______.

17. He fell heavily while skiing, but his brother hasn't ______ once.

18. I see that you have ______ the evidence clearly.

19. James speaks his lines too loudly; the director has ______ to him about that.

20. Do not drive so fast; police have stopped many who have ______ at high speeds.

Supply the correct form:

1. Professor Smith has the ability (to teach) (of teaching) Latin effectively.

2. Can you (affect) (effect) a change in office procedures?

3. I think your ideas are different (from) (than) mine about this problem.

4. Do you think his ideas will (compliment) (complement) those already carried out in this field of experimentation?

5. The person you choose as umpire must be (disinterested) (uninterested).

6. I want (you) (for you) to meet my supervisor.

7. Please (try and) (try to) finish the report before Friday.

8. Will you please (proceed) (precede) with the work I have outlined?

9. (Most) (The majority) of the time was spent in discussion of the issues.

10. What kind (of a) (of) car did you buy?

11. If my father (were) (was) here he would insist on better behavior.

12. Mary acted (like) (as if) she had already heard that story.

13. Please (let) (leave) Jane continue the report.

14. That magazine has (lain) (laid) on the table for several weeks.

15. Please (lie) (lay) your plans before the committee.

16. I believe that he has (laid) (lain) his plans carefully.

17. I am sorry that the papers fell (in) (into) the mud.

18. The other committee members (had ought) (ought) to be here soon.

19. I prefer not to pursue this discussion (farther) (further).

20. There were (continual) (continuous) sounds of hammering.

21. Between (each bite) (bites) he sipped his coffee.

22. I will (bring) (take) this book to school in the morning.

23. Agnes said that she would (bring) (take) the papers to us here.

24. The newspaper reports were (altogether) (all together) wrong.

25. The newspaper stories made (allusions) (illusions) to our past records.

Circle each word which should be omitted or which is incorrectly used:

1. Where did you stop at when you visited Denver?

2. The book laid on the table where you had laid it last night.

3. & 4. I think you have less low grades than I would have if I was taking those courses.

5. & 6. If she sung ten songs she must of become very tired.

7. I think you would have sure done better in that game than James did.

8. Is it me whom they are trying to reach by telephone?

9. Mary really didn't feel good enough to go to the party.

10. I think your work is some better than it used to be.

11. & 12. I thought you were all ready through with making those kind of mistakes.

13. None of those movies were worth seeing a second time.

14. It sure looked like her, but it was really strange to see her there.

15. & 16. The girl who everyone likes is one who they can respect.

17. Each of these flowers look better in larger flower beds.

18. & 19. If you had drank that much wine you couldn't hardly have driven home alone.

20. & 21. Neither Sally nor Sue are the right girls for that sort of job.

22. They tell us that the bus leaves most every hour from the downtown station.

23. An average of forty bushels of wheat to the acre are considered rather low in some parts of the country.

24. & 25. I feel badly about the fact that our principals have been violated.

26. The agent refused to give Jean and I our passports until we had provided more identification.

27. They asked him to speak more loudly, explaining that neither of them could hear him clear enough.

28. Her father is a famous pianist; therefore Agnes has chosen to train for it too.

29. & 30. Don't ever go to the personnel office without the office manager gave you permission.

31. I told you that you had ought to be more careful about your spelling.

32. The humor of the play was in it's absurd character contrasts.

33. Did you ask them if their papers were already for the printers?

34. This toast and marmalade taste good.

35. Each dog and each cat in the pet show are the pride of some exhibitor.

36. Every student, every instructor, and every staff member are asked to be present.

37. Many a boy and many a girl have ridden a bicycle without lights in this neighborhood.

38. Either flowers or ribbon were used to trim the hats worn in those days.

39. Either her older sisters or her mother own the books she uses in that study program.

40, 41, & 42. Neither of those kind of trees are likely to grow good here.

43. What kind of a car was that one which we passed?

44. Most all the audience left before the program ended.

45. My niece and my nephew has gone to Washington.

46. The wear and tear on a young boy's jeans are likely to be severe.

47. Each officer and each director have a vote in the annual meeting.

48. Not only their teacher but also the class president wish to have a Christmas party.

49. No eating and no drinking are permitted in the library.

50. Have either of you boys borrowed my new pen?

Addendum No. 4. English Curriculum Guide

(sample exercises in rewriting)

Rewrite each sentence in which you discover errors:

1. The reason I am worried is because I think I am going to fail the course.

2. Your spelling of that word is different than mine.

3. They met with less obstacles than they had expected.

4. How many children have you got?

5. I do not wish to continue this conversation any farther.

6. Due to the blizzard many travelers were stranded.

7. That old man acts as if he was only sixteen.

8. Does she plan to invite both you and I to the party?

9. If he was drunk I failed to notice it.

10. She acts as if she was my grandmother.

11. If I were you I would keep quiet.

12. Whom did you meet at the game?

13. They are not writing compositions as I told them to.

14. None of the cars was powerful enough to suit James.

15. I would not know how to choose among those three hats.

16. Ask Mary to try and come to the party tonight.

17. I shall never learn to cook like mother could.

18. I plan to cut that class, irregardless of the consequences.

19. I wish I ever had a chance to lie in bed late.

20. Because he had been out so late the night before, he lay in bed until noon.

21. Have you set there for the past hour?

22. I feel very badly about losing my purse.

23. She set the bundles down on the sofa.

24. The tiger lay in wait for his prey throughout the evening.

25. I think that dress looks very well on you.

26. He does not need for us to help him.

27. Someone invited me to go along with them to the game.

28. It seems to me that you are being overly cautious in your skiing.

29. The tune will be called by he who has the stronger voice.

30. The distinction lies between the conscientious student and he who is merely working for grades.

31. No matter whom you invite I shall not be there.

32. It was she I was fond of when we were children.

33. It was I who ate the cookies.

34. Our aim is to check the resort of violence in Viet Nam.

35. The manager is optimistic about their chances of a good season.

36. He may be clever, but he fails to stimulate my interest towards a conversation.

37. Some senators disagree on whether the situation is flexible.

38. He acts as if he were angry.

39. The public is invited to this gathering when tea will be served.

40. Some teachers say they could care less about the oath of loyalty.

41. He told everyone to tighten their belts.

42. He went on to sight several cases in which the penalty had been severe.

43. They told us that the war was undisputably phony.

44. He resigned his position due to illness.

45. We thought the judge was disinterested and fair.

46. The consensus was they sold the goods too cheaply.

47. He is one of the best players who has ever swung a bat.

48. He planned on going to every game of the season.

49. Do you mind me staying out a little later?

50. We received large shipments, and we distributed it as fast as we could.

Rewrite each sentence:

1. Congress must rely on experts which are supplied by the administration.

2. We are waiting on the best-conditioned patient who needs the artificial heart.

3. After National Library Week more citizens are attracted to use libraries and offer their support of library programs.

4. They tell us that that day is some ways in the future.

5. She looks like she might be a movie star.

6. He has been maintaining a precarious balance over feuding factions.

7. She said that, going on past experience, the students could not be depended on.

8. This also offends the others for not having been mentioned.

9. There is no reason not to believe that the second generation of leaders will not be more conciliatory.

10. They make no attempt to teach children educational knowledge.

11. Let's hope he will go farther in promoting this cause.

12. A look at the results to a couple of the questions may be indicative of the national mood.

13. We have, understandingly been concerned over this discussion.

14. Could this eliminate the need of hydro-electirc dams?

15. In this group companionship among elderly citizens is probably solider.

16. There is justification to explore this possibility.

17. He points out that coal can be expected to provide all the fuel requirements for electricity by which nuclear power falls short of the maximum estimate.

18. The power failures have demonstrated that all of the analysis of availability of power in post-attack areas with which I am familiar are quite meaningless.

19. They may be a very key element in the formation of the world community.

20. Remember that nothing is designed except for the use of or by man.

Rewrite each sentence:

1. The art work of the Navajo children whom volunteers have worked with will be on display.

2. They were thrown from 35 to 45 feet from the point of impact.

3. Students have the energy, but they need guidance, which should come from the intellectuals, but they "are chickens", he said.

4. Students revolt to draw attention to the situation, even if they don't get them remedied.

5. Everyone goes home thinking they have won a victory.

6. A person who exposes the truth is the most dangerous for the power structure.

7. Thirty interested students picked up applicants and 45 more Tuesday.

8. That is why I cannot help but be concerned about this problem.

9. The purpose of the meeting is to more thoroughly prepare trainees for the Peace Corps.

10. The project in South Viet Nam included the acquisition of research about the nation.

11. Colorado is well known from other worldwide events held here for its sports capability.

12. The programs will cater to both student interest as well as to the community at large.

13. We are talking about safety characteristics that tell what performance a car shall meet.

14. These are opportunities for examining when conformity becomes general.

15. These ships were docked in Baltimore since last Thursday.

16. Less upperclassmen are leaving school for fear of the draft.

17. They noted that applications had lessened.

18. Is a greater ignorance being practiced by U. S. policy?

19. They planned the attack to give support of the guerilla fighters.

20. None of them, so far as I know, consider it to be degrading.

21. She bore him a son for whom he always searched but never found.

APPENDIX V

Scientific Secretary Training Program

Curriculum Guide

for

Mathematics

I. Course objectives

A. To help dispel any fear of mathematics by developing some proficiency in a few basic algebraic processes.

B. To give a qualitative appreciation of some of the methods and processes of more advanced mathematical topics.

C. To develop some familiarity with basic mathematical terminology.

D. To develop some familiarity with a considerable range of mathematical symbols.

II. Instructional materials

A. Published materials:

No textbook was found to be suitable to the purposes of the course. Although no definite assignments were made in it, many of the students found The Science-Engineering Secretary, Stafford and Culpepper (Prentice-Hall, 1963) to be useful for collateral study in nomenclature and symbolism.

B. Unpublished materials prepared by the teacher:

1. Information sheets and exercises on various topics. (See Addendum No. 1)

2. Handwritten material to be typed. (See Addendum No. 2)

3. Examinations. (See Addendum No. 3)

III. Methods of instruction

A. Lectures and class discussions based on information sheets, exercises, and typing material (items II-B-1 and 2, above).

B. Assigned exercises, to be prepared at home or in study periods (item II-B-1, above).

C. Transcribing longhand material on typewriter (item II-B-2, above).

D. Post-examination discussions.

E. Field trip to National Bureau of Standards Computer Center. (This field trip conducted as a mathematics exercise, although discussion of computers and their applications included in Science curriculum).

F. Transcribing on typewriter from Xerox copies of actual longhand manuscripts of scientific papers of high mathematical content. (Included here, although actually a part of the Technical Typing curriculum).

IV. Units of Instruction

A total of thirty-two hours of instruction, scheduled on a basis of one hour per week for thirty-two weeks, constituted the in-class time allocation for the following units of instruction:

Unit I. Algebra I

A. The Number System
  1. Rationals
  2. Irrationals
  3. Real and Imaginary
  4. Absolute value, Equality, Inequality

B. Basic Laws
  1. Commutative
  2. Associative
  3. Distributive

C. Fundamental Operations
  1. Addition
  2. Subtraction
  3. Multiplication
  4. Division

D. Rational Integral Expressions
  1. Terms
  2. Polynomials
    a. Degree

- E. Special Products
    - 1. Perfect Squares
    - 2. Difference of 2 squares
    - 3. Squares of Polynomials

- F. Factoring
    - 1. Use of Parenthesis
    - 2. Monimial factors
    - 3. Perfect squares

- G. Exponentiation
    - 1. Exponents
    - 2. Radicals

- H. Functions and Graphs
    - 1. Variables
        - a. Dependent
        - b. Independent
    - 2. Cartesian coordinate system
        - a. Abscissa
        - b. Ordinate
        - c. Origin

- I. Linear Equations
    - 1. Root
    - 2. Slope
    - 3. Methods of Solution
        - a. Factoring
        - b. Graphing

- J. Systems of Linear Equations
    - 1. Determinants
        - a. 2nd order
        - b. 3rd order

- K. Quadratic Equations
    - 1. Methods of Solutions
        - a. Completing the Square
        - b. Quadratic Formula

Unit II. Algebra II

- A. Factorials

- B. Permutations

- C. Combinations

- D. Series

Unit III. Trigonometry

- A. Logarithms
  - 1. Common
  - 2. Natural
  - 3. Operations

- B. Slide Rule
  - 1. Use of Math Tables

- C. Polar Coodinates
  - 1. Vectors

- D. Trignometric Functions
  - 1. Acute Angles
  - 2. Double Angles
  - 3. Graphs

Unit IV. Analytic Geometry

- A. Cartesian Coordinate System

- B. Conic Sections
  - 1. St. Line
  - 2. Circle
  - 3. Parabola
    - a. Focus
    - b. Directrix
  - 4. Ellipse
    - a. Eccentricity
  - 5. Hyperbola
    - a. Asymptotes

Unit V. Calculus

- A. Theory of Limits
  - 1. Sequence
  - 2. Function

- B. Differential Calculus
  - 1. Delta Process

- C. Integral Calculus

- D. Differential Equations

Addendum No. 1. Mathematics Curriculum Guide

(sample information sheets and exercises)

Greek Alaphabet

ALPHA: α A

BETA: β

GAMMA: γ Γ

DELTA: δ Δ

EPSILON: ϵ, ε

ZETA: ζ Z

ETA: η

THETA: θ Θ

IOTA: ι

KAPPA: K

LAMBDA: λ Λ

MU: μ

NU: ν

XI: ξ

OMICRON: ο

PI: π Π

RHO: ρ

SIGMA: σ Σ

TAU: τ

UPSILON: Υ

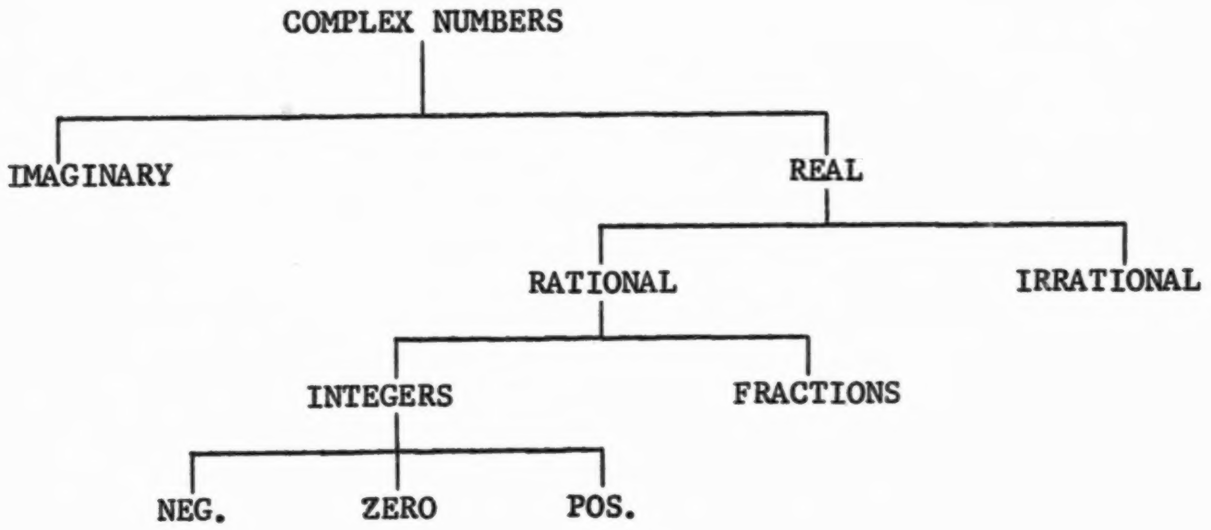
PHI: ϕ, φ Φ

CHI: χ

PSI: ψ

OMEGA: ω Ω

Number System


COMPLEX NUMBERS
IMAGINARY
REAL
RATIONAL
IRRATIONAL
INTEGERS
FRACTIONS
NEG.
ZERO
POS.

NATURAL NUMBERS - Our counting numbers, the positive integers.

A RATIONAL NUMBER is a number that can be expressed as the ration of an integer to an integer. IRRATIONAL NUMBERS cannot be expressed this way.

I. EXPONENTIATION

(1) $a^m a^n = a^{m+n}$
(2) $(a^m)^n = a^{mn}$
(3) $(ab)^n = a^n b^n$
(4) $\frac{a^m}{a^n} = a^{m-n}$, if $m>n$; $\frac{a^m}{a^n} = \frac{1}{a^{n-m}}$, if $n>m$
(5) $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

II. RATIONAL INTEGRAL EXPRESSIONS

(1) $a, ax, ax^2, ax^3, \ldots,$ are rational integral terms in x.

(2) A rational integral expression is an algebraic sum of rational integral terms.
   (a) mononial
   (b) binomial
   (c) trinomial
   . . . .
   *(d) polynomial

(3) The degree of a polynomial in one or more literal numbers is the highest degree that any term has in those numbers.

(4) Special Products
   (a) $a(x + y) = ax + ay$
   (b) $(x + y)(x - y) = x^2 - y^2$
   (c) $(x + y)^2 = x^2 + 2xy + y^2$
   (d) $(x - y)^2 = x^2 - 2xy + y^2$
   (e) $(x + a)(x + b) = x^2 + (a + b)\, x + ab$
   (f) $(ax + b)(cx + d) = acx^2 + (ad + bc)\, x + ab$
   (g) $(ax + by)(cx + dy) = acx^2 + (ad + bc)\, xy + bdy^2$
   (h) $(x^2 - xy + y^2)(x + y) = x^3 + y^3$
   (i) $(x^2 + xy + y^2)(x - y) = x^3 - y^3$
   (j) $(x + y + z) = x^2 + y^2 + z^2 + 2xy + 2yz + 2xz$

III. FACTORING

Factoring means representing a polynomial as the product of prime integral factors. (Prime meaning a rational integral expression containing no factors except itself, its negative, or ±1.)
(1) Monomial factors
(2) Difference of 2 squares
(3) Trinomials which are perfect squares
(4) Trinomials of the form $x^2 + (a + b)\, x + ab$

(5) Trinomials of the form $acx^2 + (ad + bc)\,x + bd$
(6) Sum or difference of 2 cubes
(7) Squares of polynomials

Problems

Find the value:
(1) 2^5
(2) $(-1)^7$
(3) $\left(\frac{2}{5}\right)^2$
(4) $(-3)^3$
(5) $\left(\frac{1}{6}\right)^2$

Perform the operation indicated:
(6) x^5x^2
(7) $(xy)^3$
(8) $\frac{-x^4y^{11}}{x^6y^3}$
(9) $\left(\frac{2}{3}x^2y^4\right)^3$
(10)

For each expression name the degree in x, in y, and in x & y:
(11) $3x^4 - 2x^2 + x - 5$
(12) $x^3y^2 + 5y^3 - 8x^7 + xy^3 + 3$

Multiply the first polynomial by the second:

(13) $x + 2$, $2x - 5$
(14) $6x - 7$, $3x + 4$

Factor:
(15) $3x - 9y$
(16) $4x^2 - y^2$
(17) $4a^3 + 6a^2xy^2$
(18) $9x^2 + 6x + 1$

IV. EQUATIONS

An equation is a statement that two expressions are equal. An identity is an equation where the 2 members are equal for all values of the unknown quantities.

*A conditional equation is an equation which is true only on the condition that the unknown quantities have particular values or sets of values.

These values or sets of values of the unknowns which satisfy an equation are called solutions of the equation. A value of the unknown that satisfies the equation is a root of the equation.

V. RATIONAL, INTEGRAL EQUATIONS

An equation in which each member is a rational integral expression in the unknowns is a rational integral equation.

*Linear Equation - A rational integral equation of degree 1.

General Form: $ax + b = 0$, has one root, $x = -b/a$

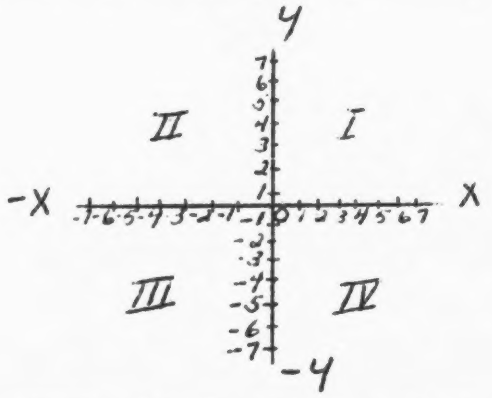
Problems: Solve for x:
(1) $5x = 20$
(2) $3x - 18 = 0$
(3) $6x + 24 = 0$
(4) $3x + 7 = 0$
(5) $4x - 7 = 2x + 3$
(6) $3x - 5 = 7x + 3$
(7) $(3x - 8) - (5x + 2) = 0$
(8) $2(4x - 7) - 5(3x + 2) = x$
(9) $\frac{6}{x} = -1$
(10) $\frac{2x - 3}{x + 3} = \frac{4}{5}$

VI. FUNCTIONS & GRAPHS

A number or number symbol is a constant if it's assumed that it has just one value through out a problem. A quantity or number symbol is variable if, in a problem, it is free to take on any one or more of a certain set of values. This set of values is called the range of a variable.

*When two variables x & y are arranged in the form of a conditional equation, say $y = x + 10$, and x is free to take on any value, x is called the independent variable and y is called the dependent variable. Also, y is said to be a function of x.

Functions are commonly displayed by means of a graph.



The above graph forms the basis of the Cartesian Coordinate System. It has an origin, x-axis, and y-axis. In locating a point, the x-coordinate is called the abscissa and the y-coordinate is called the ordinate.

Exercises: Construct a graph (Cartesian Coordinate System) and locate the following points.

(1)	(2,5)	(3)	(3,-8)	(5)	(-5,-3)
(2)	(-3,4)	(4)	(-0,0)	(6)	(0,0)

Graphing is one method of solving linear equations. There is an important connection between a function and the equation formed by setting the function equal to zero. The root of the linear equation

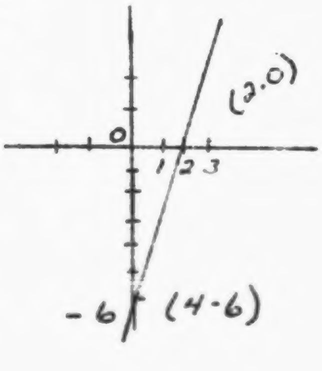
(1) $ax + b = 0$

is evidently the value of x for which the linear function

(2) $y = ax + b$

is equal to zero. The point where the graph of the function crosses the x-axis is clearly the point where $y = 0$. *The root of the equation $ax + b = 0$ is equal to the abscissa of the point where the graph of the function $y = ax + b$ crosses the x-axis.

Example: Solve the equation $5x - 4 = 2x + 2$.



The equation reduces to $3x - 6 = 0$. The function we graph is $y = 3x - 6$.

x	-1	0	1	2	3
y	-9	-6	-3	0	3

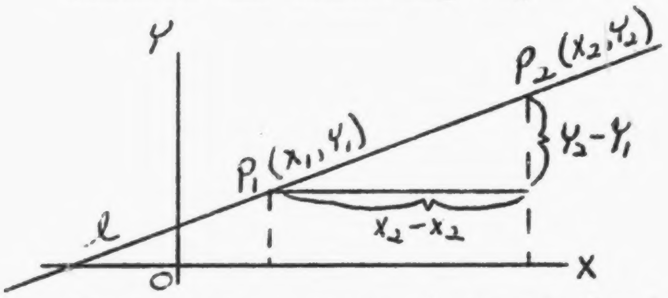
Root: $x = 2$

Problem: Solve the following equations graphically, and check by substituting in the original equations.

(1) $2x - 8 = 0$	(3) $3x - 2 = x + 4$
(2) $\frac{1}{2}x - 3 = 0$	(4) $6x + 1 = 4x - 5$

VII. SLOPE OF A STRAIGHT LINE

Observe the following figure of a graph and coordinate system.



P_1 & P_2 are two points on the graph

*Definition: The Slope of the line ℓ is equal to the ratio $\frac{y_2 - y_1}{x_2 - x_1}$.

Problems: Find the slope of the line joining the following points.

(1) (1,3) & (5,6)	(3) Through the origin & (4,3)
(2) (-3,2) & (2,5)	(4) (5,0) & (0,3)

Draw the straight line described:

(5) Through origin, slope = 2
(6) Through (-2,5), slope = 5/2
(7) Through (2,-3), slope = -1

VIII. SYSTEMS OF LINEAR EQUATIONS

A linear equation in two variables x & y is written in the general form

$$ax + by = c$$

Writing this equation as y equalling a function of $x(y=f(x))$, we have

$$y = -\frac{a}{b}x + \frac{c}{b}$$

and this can be graphed similar to preceding examples. The solution of the equation is the values of the abscissa and ordinate where the graph crosses the x & y-axes.

Linear equations in 2 unknowns often arise in pairs, the general form being

$$(1) \quad \begin{aligned} a_1x + b_1y &= c_1, \\ a_2x + b_2y &= c_2. \end{aligned}$$

The pair of equations are referred to as a system and are solved simultaneously.

There are several methods one can employ to solve simultaneously systems of equations. One common and very useful method is determinants.

*Determinants of second order. If a, b, c, & d represent any numbers, the symbol

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix}$$

is called a determinant of second order, of which a, b, c, d are the elements. The value of a second order determinant equals

$$ad - bc.$$

To solve (1) we set up the following determinants for x & y:

$$x = \frac{\begin{vmatrix} c_1 & b_1 \\ c_2 & b_2 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix}} = \frac{c_1b_2 - c_2b_1}{a_1b_2 - a_2b_1},$$

$$y = \frac{\left|\begin{array}{cc} X & Y \\ a_1 & c_1 \\ a_2 & c_2 \end{array}\right|}{\begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix}} = \frac{a_1c_2 - a_2c_1}{a_1b_2 - a_2b_1}.$$

Exercises: Use determinants to solve the following system of equations.

$$(1) \quad \begin{aligned} x - 2y &= -4 \\ 3x + y &= -5 \end{aligned} \qquad (2) \quad \begin{aligned} 4x - y &= 5 \\ x - 3y &= 4 \end{aligned}$$

(3) $3x - y = 15$
$2x + y = 10$

(4) $3x + 4y = 11$
$3x - 2y = -1$

Graph the equations in (1) & (2) to visually verify your solutions for x & y.

Addendum No. 2. Mathematics Curriculum Guide

(handwritten material to be typed)

MATHEMATICS NOTES

I. Factorial Notation

Def: A factorial is the mathematical notation for grouping and multiplying a sequence of terms. The terms are unique in that they begin with unity, are in unit increments, and are consecutive.

Examples:

(1) "Factorial 4" or "4 factorial" is written as $4! = 1 \cdot 2 \cdot 3 \cdot 4$.

(2) "n factorial" $= n! = 1 \cdot 2 \cdot 3 \ldots (n-2)(n-1)n$.

II. Permutations and Combinations

Def. 1: Each of the arrangements which can be made by taking some or all of a number of things is called a permutation.

Def. 2: Each of the groups or selections which can be made by taking some or all of a number of things is called a combination.

Theorem I: The number of permutations of n different things taken r at a time is

$$_nP_r = n(n-1)(n-2)\ldots(n-r+1) = \frac{n!}{(n-r)!}.$$

Theorem II: The number of permutations of n different things taken all at a time is $_nP_n = n(n-1)(n-2)\cdots 3\cdot 2\cdot 1 = n!$.

Examples:

Given the letters A, B, C,

(1) $_3P_1 = 3$. Applying this to A, B, C we can permute the letters in only 3 ways: A, B, or C.

(2) $_3P_2 = 3\cdot 2 = 6$. Applying this to A, B, C, we have AB, BA, AC, CA, BC, CB.

(3) $_3P_3 = ?$ (Use Th. II to find the result applied to A, B, C.

Combinations are different from permutations in that they do not take into account the arrangement of the objects.

Theorem III: The number of combinations of n different things taken r at a time is

$$_nC_r = \frac{n(n-1)(n-2)\ldots(n-r+1)}{r!}, \text{ or}$$

$$_nC_{n-r} = \frac{n!}{r!(n-r)!}.$$

Note: $_nC_r = {_nC_{n-r}}$.

Examples:

given the letters A, B, C, D.

(1) ${}_4C_2 = \frac{4 \cdot 3}{2!} = 6$. applied to A, B, C, D, we have

AB, AC, AD, BC, BD, CD.

(2) ${}_4C_3 = ?$ (Use Th. III to find the result applied to A, B, C, D.)

TRIGONOMETRY

I. Logarithms.

A logarithm is a mathematical tool to simplify numerical computation. We can replace the operations of multiplication and division by addition and subtraction; the taking of powers and roots by mere multiplication and division.

A logarithm is an exponent.

If b, x and N are 3 numbers such that

(1) $b^x = N$

then we say x is the logarithm of N to the base b, or

(2) $x = \log_b N$.

Def. The logarithm of a number to a given base is the exponent, or the power to which the base must be raised to yield the number. (In referring to (2), N is called the anti-logarithm of x to the base b.)

Examples:

(1) Since $5^3 = 125$, $\log_5 125 = 3$.

(2) Since $3^{-4} = 1/81$, $\log_3 (1/81) = -4$.

(3) Since $2^{4/5} = \sqrt[5]{16}$, $\log_2 (\sqrt[5]{16}) = 4/5$.

Note: $\log_b b = 1$ and $\log_b 1 = 0$, for any base b.

Common Logarithm

The system of logarithms whose base is 10 is called the common (Briggs) system.

Consider the following:

$$\log 200 = 2.30103.$$

The integral part of the above logarithm is called the characteristic. The fractional part is the mantissa.

The following rules govern operations involving logarithms:

(1) $\log(M \cdot N) = \log M + \log N.$

(2) $\log(M/N) = \log M - \log N.$

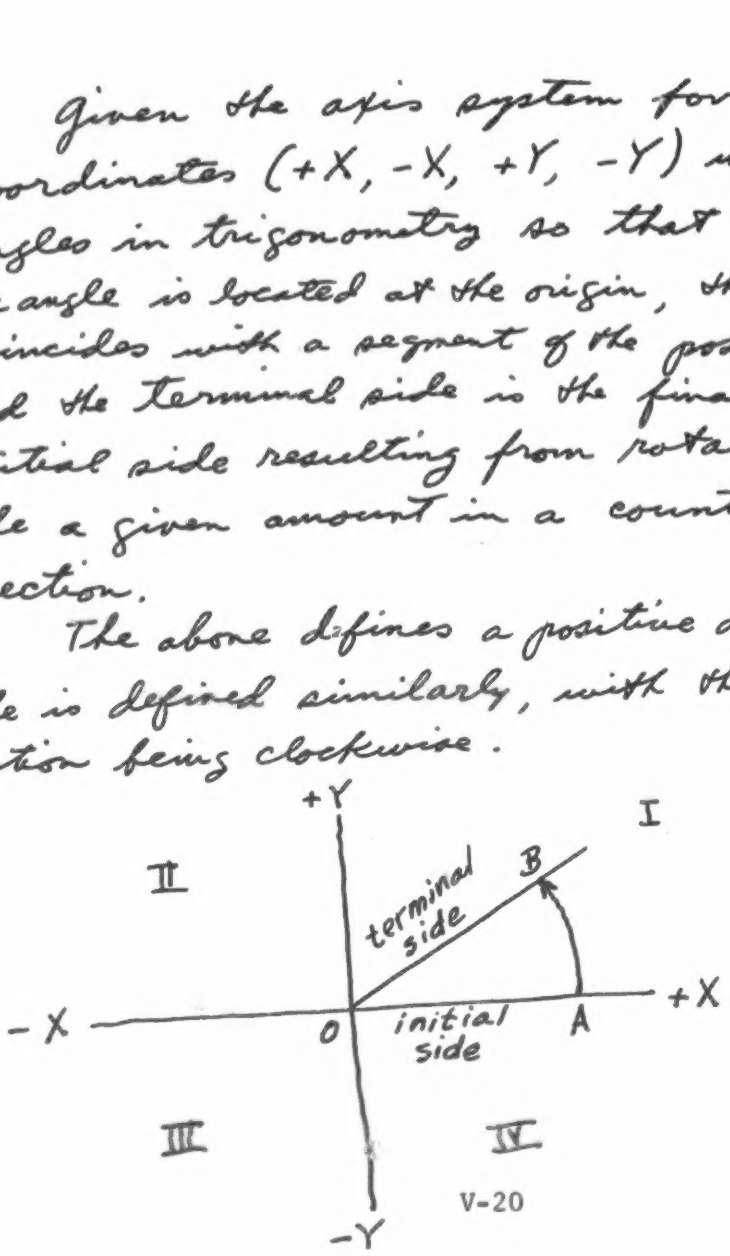
(3) $\log M^p = p \log M.$

The name trigonometry is derived from two Greek words meaning "measurement of triangles." In the development of methods for the solution of triangles certain properties of angles arise. It is the study of these properties and their application to various problems that constitute the subject matter of trigonometry.

To begin with, we will define the *standard position* of an angle.

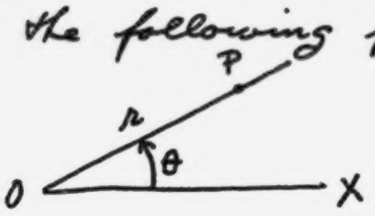
Def. Given the axis system for Cartesian coordinates (+X, -X, +Y, -Y) we will reference angles in trigonometry so that the *vertex* of the angle is located at the origin, the *initial* side coincides with a segment of the positive X-axis, and the terminal side is the final position of the initial side resulting from rotating the initial side a given amount in a counter-clockwise direction.

The above defines a positive angle. A negative angle is defined similarly, with the direction of rotation being clockwise.



Rectangular coordinates are one method of specifying points. Another method is by using a *distance* and *direction* from a fixed point.

Consider the following figure:



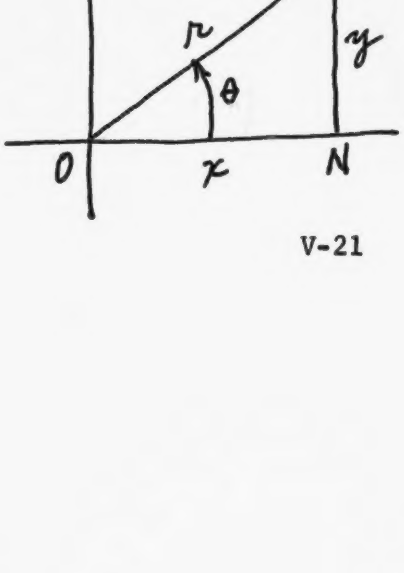
The directed line segment OP is called the *radius vector* of point P. The directed angle is called the vectorial angle of point P.

The length of the radius r, the amount of rotation of the vectorial angle θ, form the *polar coordinates* of point P.

Trigonometric Functions of an Acute Angle

Six trigonometric ratios (or functions) exist with such frequency in dealing with triangles that they have come to have great mathematical importance in solving for angles.

Consider the following figure:



Def.

(1) The ratio $\frac{NP}{OP}$ is the sine of θ; $\sin\theta = \frac{y}{r}$,

(2) The ratio $\frac{ON}{OP}$ is the cosine of θ; $\cos\theta = \frac{x}{r}$,

(3) The ratio $\frac{NP}{ON}$ is the tangent of θ; $\tan\theta = \frac{y}{x}$,

(4) The ratio $\frac{OP}{NP}$ is the cosecant of θ; $\csc\theta = \frac{r}{y}$,

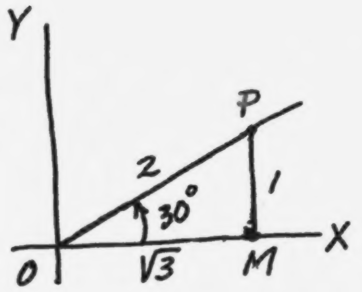
(5) The ratio $\frac{OP}{ON}$ is the secant of θ; $\sec\theta = \frac{r}{x}$,

(6) The ratio $\frac{ON}{NP}$ is the cotangent of θ; $\cot\theta = \frac{x}{y}$.

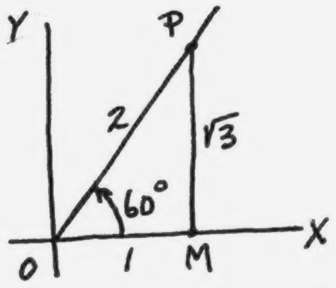
II. Trigonometric Functions of Certain Particular Angles.

The exact values of the trigonometric functions of angles of 30°, 45°, 60°, and of certain related angles may be found directly by use of the trigonometric functions and by the use of simple geometric relations.

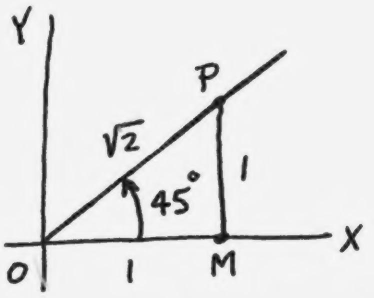
Observe the following constructions:



(a)



(b)



(c)

All of the angles are in the standard position. It has been found that when these angles are constructed, the values of the sides of the triangles formed by dropping a perpendicular from P to M take on the above values. We find their trigonometric functions occurring in a great many applications.

$\sin 30° = \frac{y}{r} = \frac{1}{2}$

$\cos 30° = \frac{x}{r} = \frac{\sqrt{3}}{2}$

$\tan 30° = \frac{y}{x} = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$

$\sin 60° = \frac{y}{r} = \frac{\sqrt{3}}{2}$

$\cos 60° = \frac{x}{r} = \frac{1}{2}$

$\tan 60° = \frac{y}{x} = \frac{\sqrt{3}}{1} = \sqrt{3}$

$\sin 45° = \frac{y}{r} = \frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2}$

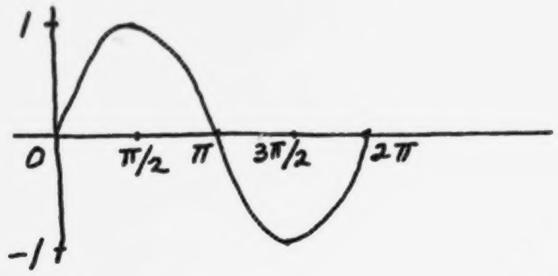
$\cos 45° = \frac{x}{r} = \frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2}$

$\tan 45° = \frac{y}{x} = \frac{1}{1} = 1$

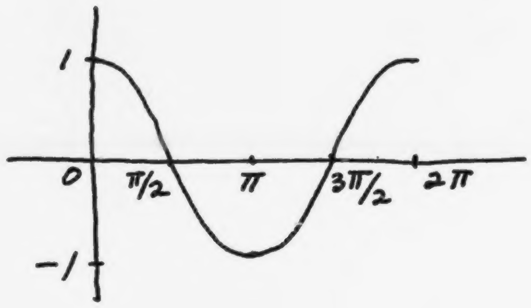
III. Graphing of Trigonometric Functions

The trigonometric functions can be graphed similar to algebraic functions.

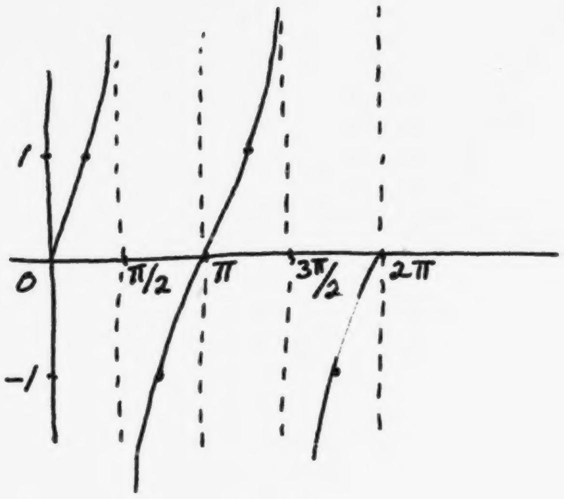
(1) $\sin\theta$:



(2) $\cos\theta$:



(3) $\tan\theta$:



IV. Fundamental Relationships

The trigonometric functions of a single angle are related to each other by certain fundamental relations we will now proceed to consider.

A. Reciprocal Relations

(1) $\csc\theta = 1/\sin\theta$,

(2) $\sec\theta = 1/\cos\theta$,

(3) $\cot\theta = 1/\tan\theta$.

B. Square Relations

(1) $\sin^2\theta + \cos^2\theta = 1$,

(2) $1 + \tan^2\theta = \sec^2\theta$,

(3) $1 + \cot^2\theta = \csc^2\theta$.

C. Quotient Relations

(1) $\tan\theta = \sin\theta/\cos\theta$,

(2) $\cot\theta = \cos\theta/\sin\theta$.

TOPICS FROM ANALYTICAL GEOMETRY

I. Introduction

The chief feature of analytic geometry which distinguishes it from Euclidean geometry is its extensive use of algebraic methods in the solution of geometric problems. Analytic Geometry is the study of curves and equations, functions and graphs, and the Cartesian coordinate system.

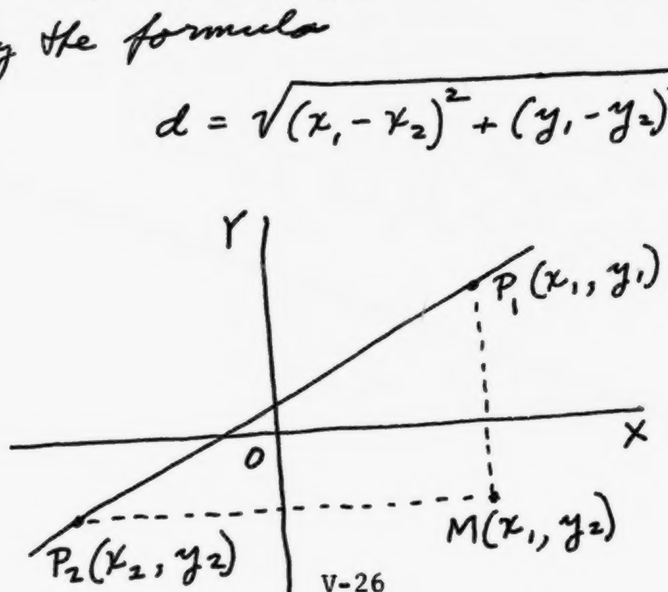
II. Cartesian Coordinates

To begin with, the plotting of points is studied. (We have covered cartesian coordinates fairly extensively, so we will omit this.)

We should understand the following theorem:

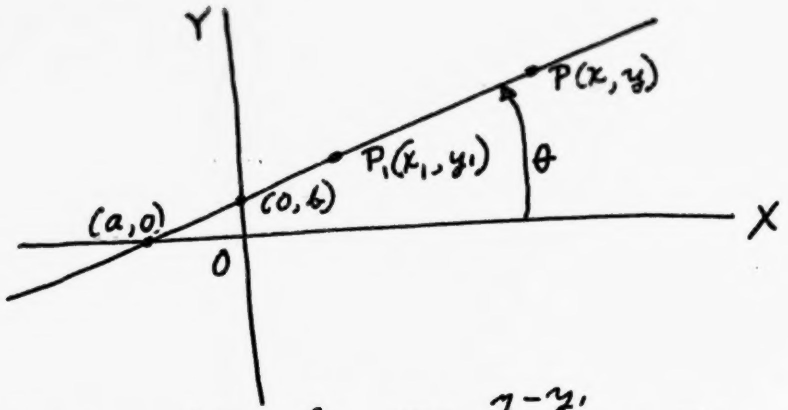
THEOREM: The distance between any two points, $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$ is given by the formula

$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}.$$



III. The Straight Line

The equation of a straight line can be written in several different forms. Consider the following figure:



By the slope formula, $m = \frac{y - y_1}{x - x_1}$, or

(1) $y - y_1 = m(x - x_1)$; Point-slope form.

If a second point is known on the above figure we can solve for the slope by

$m = \frac{y_1 - y_2}{x_1 - x_2}$. Substituting this into (1), we have

(2) $y - y_1 = \frac{y_1 - y_2}{x_1 - x_2}(x - x_1)$; Two-Point form.

If the slope and y-intercept are given, then $P_1(x_1, y_1) = (0, b)$. Substituting this into (1) gives $y - b = m(x - 0)$, or

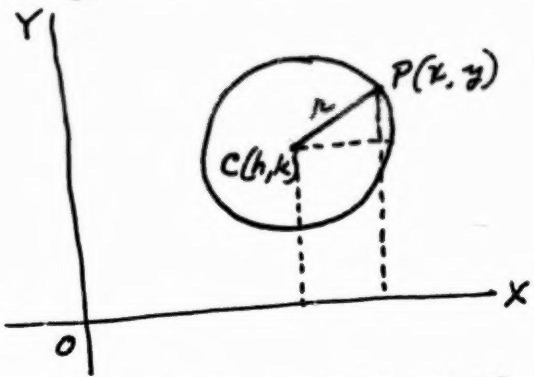
(3) $y = mx + b$; Slope-intercept form.

If both the x and y intercepts are given, $m = -b/a$. Then by (1), $y - b = \frac{-b}{a}(x - 0)$, or

(4) $\frac{x}{a} + \frac{y}{b} = 1$; Intercept form.

IV. The Circle

Only one standard form exists for the equation of a circle in rectangular coordinates.

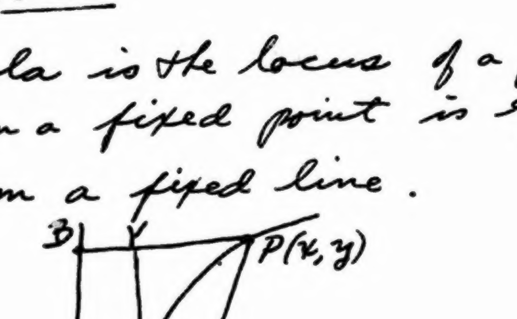


Let the coordinates of the center of the circle be (h, k) and the radius be r. Let $P(x, y)$ be any point on the circle. By the distance formula, $r = \sqrt{(x-h)^2+(y-k)^2}$, and we obtain the standard equation of the circle:

$$(x-h)^2+(y-k)^2 = r^2.$$

V. The Parabola

The parabola is the locus of a point such that its distance from a fixed point is equal to its distance from a fixed line.



The fixed point is called the *focus*, and the fixed line, the *directrix*. The line through the focus perpendicular to the directrix is called the *principal axis*.

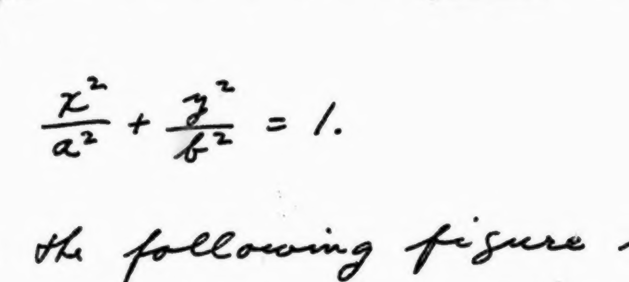
From the above figure, the general equation of the parabola is

$$y^2 = 2px.$$

The line joining the focus F to any point on the parabola is a focal radius; a chord passing through F is a focal chord. The focal chord parallel to the directrix is called the latus rectum.

VI. The Ellipse

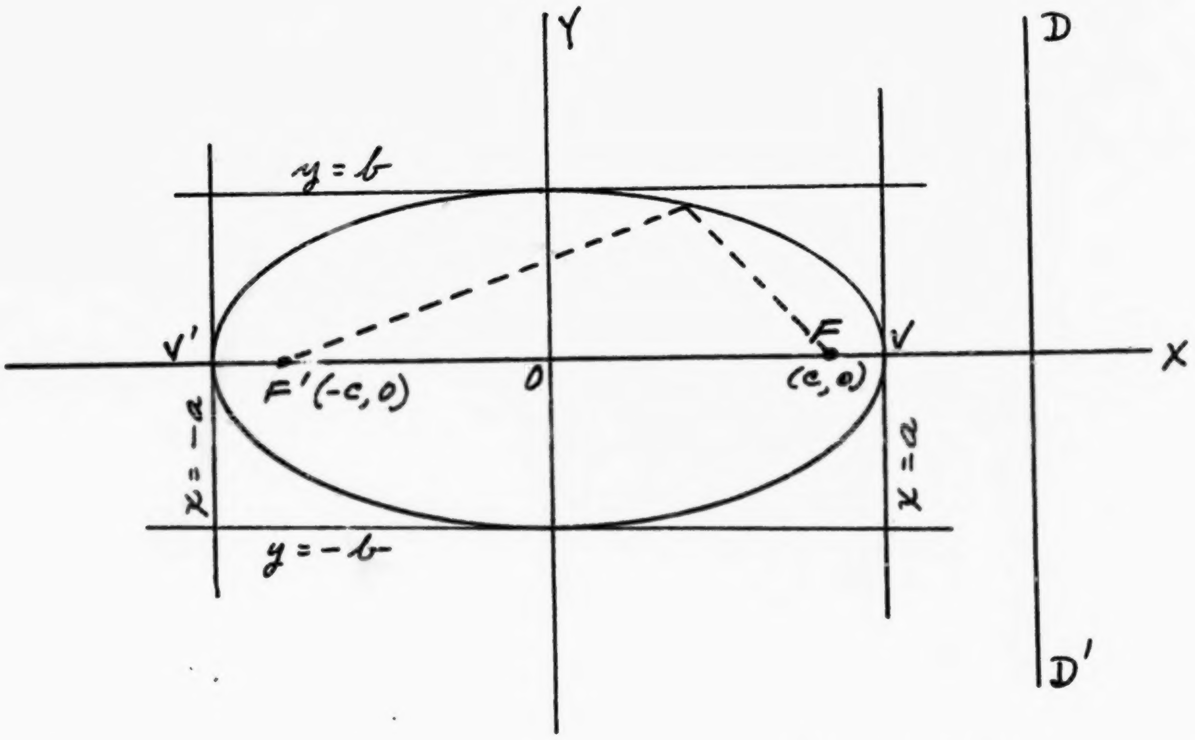
The ellipse is the locus of a point such that the sum of its distances from two fixed points is constant.



The two points are called foci. The equation of the ellipse is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1.$$

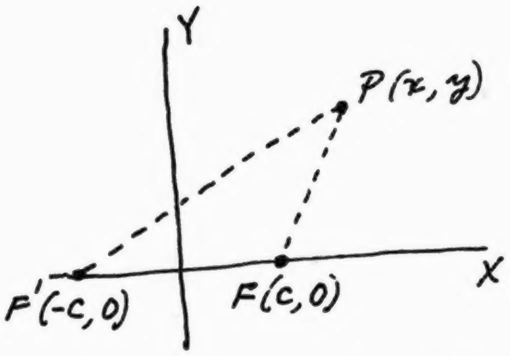
From the following figure we can observe intercepts at ±a on the x-axis, and ±b on the y-axis.



The shape of the ellipse depends on the relative values of c and a. The fraction c/a is called the eccentricity, and is denoted by e. For the ellipse, $0<e<1$. The line DD' is called a directrix.

VII. The Hyperbola

The hyperbola is the locus of a point such that the difference of its distances from two fixed points is constant.

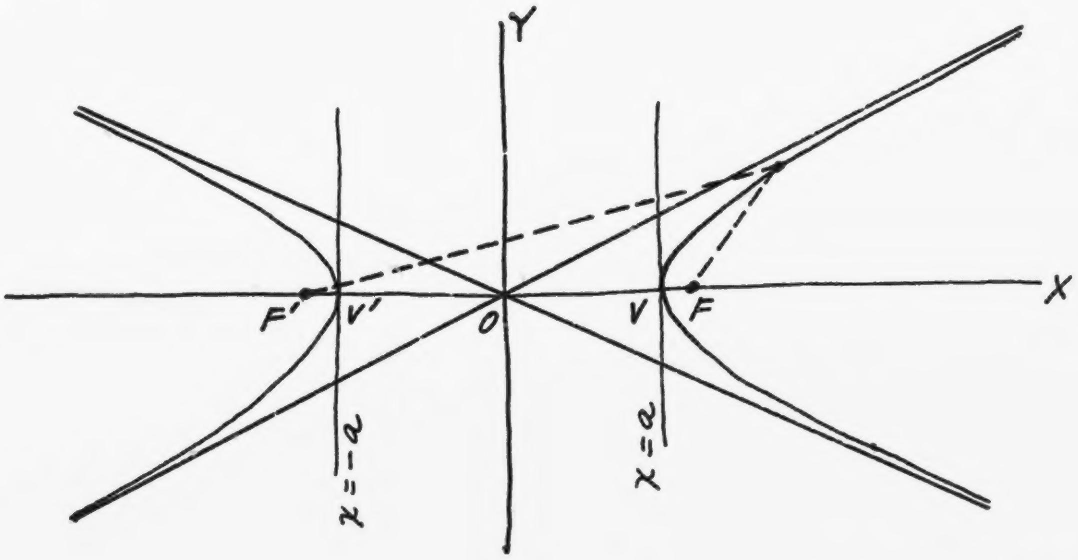


As with the ellipse, the two points are called foci, and the line passing through them is the principal axis.

The equation of the hyperbola is

$$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1.$$

The intercepts on the x-axis are ± a, and the y-intercepts are imaginary.



The eccentricity of a hyperbola is always greater than 1: $e > 1$.

The lines running diagonally through the origin are called asymptotes. The branches of the hyperbola approach the asymptotes, but never touch them.

TOPICS FROM ELEMENTARY CALCULUS

I. Introduction

What is calculus? This question can only be answered after applying the fundamental concepts upon which the course is based.

The name calculus is Latin. In ancient times it was referred to as a stone used as a counter for reckoning. Of late it has come to define the branch of mathematics used in applying the physical sciences. Calculus was developed in the 17th century. The two great men involved were Isaac Newton (1642-1727) and Gottfried Leibnitz (1646-1716), who worked independently of one another. It is the mathematical tool used in analytical studies of various motions.

The nature of continuous motion was a subject of much speculation to the early Greeks. The quantitative and qualitative assessments of velocity and acceleration were impossible without calculus. Also it was now possible to calculate areas of curved surfaces. Because of this the two major concepts of calculus are interpretable in terms of motion and area.

II. Limits

There are several types of limits. In calculus we will study the limit involving functions.

When two measureable quantities are so

related that the amount x of one of them determines uniquely the amount y of the other, we may inquire as to the rate of change of y with respect to x. If x and y are typical corresponding quantities, and x_0 and y_0 are fixed values, we define the rate of change of y with respect to x, for the particular value x_0, as the limit

$$(1) \quad \lim_{x \to x_0} \frac{y - y_0}{x - x_0}.$$

This limit is called the derivative of y with respect to x, at $x = x_0$.

III. The Derivative

In defining (1), we discussed varying quantities and rate of change. Differential calculus establishes a measure of this change with mathematical precision. The increment of a variable in changing from one numerical value to another is the difference resulting from subtracting the first value from the second. An increment in x is denoted by Δx.

Definition: The derivative of a function is the limit of the ratio of the increment of the function to the increment of the independent variable, when the latter increment approaches zero as a limit.

To help explain the above definition let us consider the following function:

$$(1) \qquad y = f(x),$$

with x having a fixed value. Let x take on an increment Δx; hence y takes on Δy, and the function now has the new value

$$(2) \qquad y + \Delta y = f(x + \Delta x).$$

To find the increment of the function, subtract (1) from (2):

$$(3) \qquad \Delta y = f(x + \Delta x) - f(x).$$

Dividing both members by the increment of the variable, Δx,

$$(4) \qquad \frac{\Delta y}{\Delta x} = \frac{f(x + \Delta x) - f(x)}{\Delta x}.$$

The limit of (4) as $\Delta x \to 0$ is by the above definition the derivative of the function $f(x)$,

$$(5) \qquad \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(x+\Delta x) - f(x)}{\Delta x}.$$

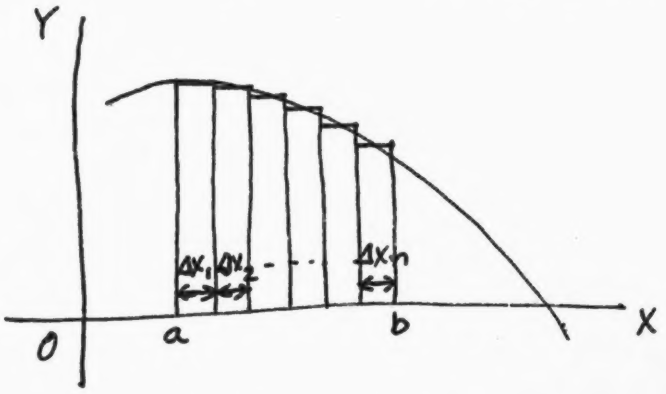
This is now labelled with a special symbol:

$$\frac{dy}{dx} = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x}.$$

IV. The Integral

We will now consider the inverse operation of differentiation, integration. While differentiation is largely a process of finding the limit of a difference, integration is the process of finding the limit of a sum.

Consider the following figure:



Divide the interval from $x = a$ to $x = b$ into n subintervals and erect ordinates at the points. Continue the construction to form n rectangles under the curve. Then the sum of the areas of the rectangles approximates the area under the curve.

Let us assume that some function $f(x)$ defines the curve, and that it has a derivative $\phi(x)$.

(a) The length of each subinterval is
$\Delta x_1, \Delta x_2, \ldots, \Delta x_n$.

(b) The abscissas of the points in the subintervals are
$x_1, x_2, \ldots, x_n$.

(c) The corresponding ordinates are
$\phi(x_1), \phi(x_2), \ldots, \phi(x_n)$.

(d) The area of each rectangle then is
$\phi(x_1)\Delta x_1, \phi(x_2)\Delta x_2, \ldots, \phi(x_n)\Delta x_n$.

(d) Hence the area under the curve is then equal to

$$\lim_{n \to \infty} \left[\phi(x_1)\Delta x_1 + \phi(x_2)\Delta x_2 + \ldots + \phi(x_n)\Delta x_n \right].$$

We now define the definite integral from this limit as being

$$\int_a^b \phi(x)\,dx = \lim_{n \to \infty} \sum_{i=1}^{n} \phi(x_i)\Delta x_i\,.$$

This is the basis of the fundamental theorem of Integral Calculus.

Addendum No. 3. Mathematics Curriculum Guide

(sample examinations and quizzes)

(1) Four operations are fundamental in algebra as in arithmetic. They are: ________________, ________________, ________________, and ________________.

(2) In the rational integral term αx^2, α is called the ____________,
x is called the ____________,
and 2 in x^2 is the ____________.

(3) What is the general name the following expression is known by: $2x^4 - 7x^3 + 3x^2 - 5x + 2$, ____________. Its degree is _____.

(4) What is the name of the process that reduces a given algebraic expression into two or more algebraic expressions which when multiplied together produce the given expression? ____________.

(5) A statement that two expressions are equal is called an ______.

(6) In the following expression $y = 2x + 6$, y is said to be a function of x. Also y is the ____________________ and x is the ____________________.

(7) The value of x-coordinate where the graph of the function $y = ax + b$ crosses the x-axis is the ________________ of the equation $ax + b = 0$.

(8) The location where the x & y axis cross each other in the Cartesian coordinate system is called the ____________________.

(9) Place the following equation in general form: $2x - 1 = 3x + 7$.
____________________.

(10) The x & y coorinates respectively in locating a point are ________________ and ____________________.

Solve:

(11) $8\left[- 2 + \left\{4-2(7 - \frac{8}{4}) + 6\right\} - 3\right]$

(12) 3^3

(13) $\frac{(-27x^3)(36y^2)}{(16y^4)(31x^4)}$

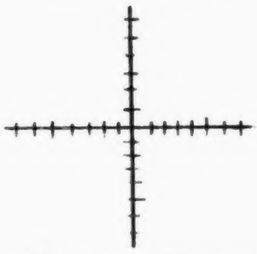
(14) $3x - 5 = 7x + 3$

(15) $2x^2 + 3xy$

(16) $\frac{2}{x - 2} - \frac{1}{x - 3} = 0$

Graph and label intercepts:

(17) $2x + y = 4$



(18) $x = 5$

Match expressions and labels:

(19) (x,y) ____
(20) $2x - 7 = 0$ ____
(21) $cx + cx^2$ ____
(22) $\neq$ ____
(23) $(0,0)$ ____
(24) $g = f(x)$ ____
(25) $(x - 2)(x - 2)$ are ____ $x^2 - 4$.

(a) binomial
(b) origin
(c) factors
(d) ordered pair
(e) function
(f) monomial
(g) root
(h) linear equation
(i) not equal

(1) Write the general form of the quadratic equation. ____________

(2) How does a pure quadratic differ from the general quadratic? ________________________________

(3) Given the coordinates (x_1,y_1) & (x_2,y_2) on the graph of a straight line, the value $\frac{y_2 - y_1}{x_2 - x_1}$ is a ______________________ representing the ________________________ of the line.

(4) Given the equation $4x + 2y = 8$ that we wish to solve by graphing, the first step is to rewrite the equation as $y = 4 - x$. Now we have defined the ____________________ of the equation which we can graph.

(5) What distinguishes a quadratic equation from a linear equation? ____________________________________ How does this effect the roots? ______________________________

(6) Given "n" linear equations in "n" unknowns, together they are referred to as a _______________ ________.

(7) List three methods of solving a quadratic equation. ____________
____
____

(8) While solving for a root we may obtain an answer such as $x = \sqrt{-16}$. The root is said to be ______________________.

(9) Observe the following system of equations. To solve for x, y, & z we must solve the equations ______________________.

$$\begin{aligned} a_1x + b_1y + c_1z &= d_1 \\ a_2x + b_2y + c_2z &= d_2 \\ a_3x + b_3y + c_3z &= d_3 \end{aligned}$$

(10) The following method used to solve (9) is called a _______. Its order is ____________________.

$$x = \frac{\begin{vmatrix} d_1 & b_1 & c_1 \\ d_2 & b_2 & c_2 \\ d_3 & b_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}}$$

(11) & (12) Set up the solutions for y & z.

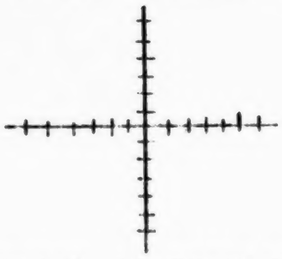
Solve the following problems:

(13) $3x^2 = 2 - 5x$

(14) $\begin{vmatrix} 6 & 3 \\ 4 & -2 \end{vmatrix}$

(15) $\begin{aligned} 2x + y &= 4 \\ y &= 6 \end{aligned}$

(16) Graph problem (15).



Match expressions and labels:

(17) $\dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ _____(a) Slope

(18) Locus of points that a function of a quadratic equation graphs _____(b) Determinant

(19) 3i _____(c) Quadratic formula

(20) $\frac{\Delta y}{\Delta x}$

(21) $\begin{vmatrix} e & f \\ g & h \end{vmatrix}$

(22) $y = \frac{a}{b}x + \frac{c}{b}$

(23) $b^2 - 4ac$

_____(d) Discriminant

_____(e) Imaginary number

_____(f) Parabola

_____(g) Factors

_____(h) Linear function

_____(i) Exponent

(1) Below are some abbreviations. Write the mathematical terms they represent.

(a) cot
(b) cos
(c) log
(d) sin
(e) sec
(f) ln
(g) csc

(2) What does 4: mean? ____________________

(a) What is its numerical value? ____________________

(3) What does $12^{P}3$ mean? ____________________

(4) A logarithm is an ____________________.

(a) If a, x, and y are 3 numbers $\ni$ $a^x = y$ then this equation can be written logarithmically as ____________________.

(b) What is a? ____________________

(5) Suppose the following logarithm is given: 2.47712.

(a) 2 is the ____________________.
(b) 47712 is the____________________.

(6) In defining angles, clockwise rotation is ____________________.

Terms	Definitions or Equivalent Statements
(7) Polar coordinate	______(a) Solving for a value between 2 known values
(8) "is contained in"	______(b) $\frac{n!}{r!(n-4)!}$
(9) extrapolation	______(c) $1 \cdot 2 \cdot 3 \cdot \cdots \cdot (n-1) \cdot n$
(10) combination	______(d) A mathematical statement requiring proof
(11) interpolation	______(e) $\frac{n!}{(n-r)!}$
(12) theorem	______(f) (r,o)
(13) permutation	
(14) "n" factorial	

Solve

(15) $\log b^1 =$ ____________

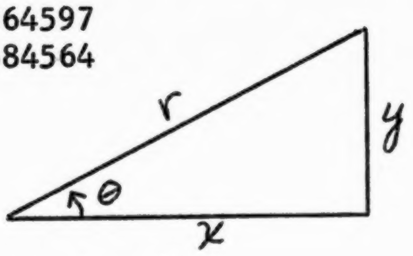
(16) $\log b^b =$ ____________

(17) Suppose the following tabular values are given from a log table:

x	log x
215	3324384
216	3344537
217	3364597
218	3384564

Compute log 2165.0

(18) Given the following angle:



(a) How many trig. functions are there? ____________________

(b) Define as many as you can from the above figure.

Terms or Symbols	Definitions or Equivalent
(1) $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$	______(a) The fraction c/a that determines the slope or general shape of a given curve

(2) $\frac{x}{a} + \frac{x}{b} = 1$

(3) St. line, circle, parabola, ellipse, etc

(4) $x^2+y^2-2hx-2ky+h^2+k^2=r^2$

(5) Eccentricity

(6) $\lim_{z \to z_0} z$

(7) dv/du

(8) The _____ is the locus of a point such that its distance from a fixed point is equal to its distance from a fixed line.

(9) The "fixed line" in (8)

(10) The "fixed point" in (8)

(11) $\lim_{n \to \infty} \sum_{1}^{n} \phi (x_i) \cdot \Delta x$

(12) Δh

(13) $\lim_{x \to 0} \frac{\Delta y}{\Delta x}$

(14) d/du

(15) asymptotes

(16) The process of integration is that of finding the limit of a ____.

(17) $\left\{ \frac{1}{n+1} \right\}$

_____(b) parabola

_____(c) $h_{1+1} - h_1$

_____(d) dy/dx

_____(e) distance formula

_____(f) operator for differentiating

_____(g) $\int_a^b f(x)dx$

_____(h) St. line, 2 point form

_____(i) differential of v with respect to u

_____(j) circle

_____(k) focus

_____(l) St. lines which the branches of a hyperbola approach but never touch

_____(m) directrix

_____(n) difference

_____(o) continuity

_____(p) conic sections

_____(q) ellipse

(18) The process of differentiation is that of finding the limit of a _____.

(19) $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

(20) $r = \sqrt{x^2 + y^2}$

_____(r) limit of z

_____(s) sum

_____(t) sequence

_____(u) radius of a circle

APPENDIX W

Scientific Secretary Training Program

Curriculum Guide

for

Science

I. Course objectives

A. To give an appreciation and understanding of the "scientific method" and experimental approach to science.

B. To provide at least a qualitative understanding of the principles underlying several basic fields in the physical and biological sciences.

C. To develop a familiarity with, and qualitative understanding of, a wide range of basic scientific and technological terminology.

D. Familiarization with library research related to the study of physical and biological sciences.

II. Instructional materials

A. Published materials:

The course was based on the following paperback books. Definite reading assignments covered the greater part of each of them.

1. One, Two, Three...Infinity: Gamow
(Viking Press, 1947)

2. Understanding Chemistry: Lessing
(Interscience Publishers, 1959)

3. Earth, Sea and Air: Spar
(Addison-Wesley, 1965)

4. The Dawn of Like; Rush
(Signet Science Library T2192, 1957)

5. Electronics in Everyday Things; Vergara
(Barnes and Noble, 1961)

6. Computers; Halacy
   (Dell, 1962)

B. Periodical: each student received a weekly copy of Science News

C. Unpublished materials by the teacher:

   1. Study guides accompanying reading assignments. (See Addendum No. 1 for specimens.)

   2. Vocabulary and terminology lists. (See Addendum No. 2 for specimens.)

   3. Examinations and short quizzes. (See Addendum No. 3 for specimens.)

III. Methods of Instruction

A. Lectures and class discussions on assigned material, study guide material, visiting lecturer material, etc.

B. Vocabulary drills--dictation of words and terms from assigned material: spelling, definition, shorthand.

C. Visiting lecturers:

   1. George Gamow (physicist, author of assigned One, Two, Three...Infinity) - muscle contraction.

   2. Robert Low (meteorologist, Associate Director of University of Colorado U.F.O. project) - current research on unidentified flying objects.

   3. Richard Holland (Biology instructor, Boulder High School)-regional ecology (with slides).

   4. Joseph Rush (physicist, author of assigned Dawn of Life)-development of scientific research.

   5. Robert Lander (engineer, Public Service Company of Colorado) - air pollution.

   6. John Knox (geographer, Colorado State College, Greeley, Colorado) - geography and mapping.

   7. Richard Webb (Automation Industries, Inc.) - data processing.

8. Lavere Wilson (head, mathematics department, Boulder High School) - binary mathematics and computers.

D. Field trips:

1. Geology and ecology of Boulder region.

2. University of Colorado Norlin Library (main library)

3. University of Colorado Engineering Library.

4. Chemistry, Physics, Biology laboratories at Fairview High School.

E. Films:

1. Atomic Energy for Space (AEC)

2. SNAP 8 (AEC)

F. Laboratory projects:

1. Biological microscopy (at Fairview High School, Boulder).

2. Map reading and interpretation (in classroom).

3. Quantitative investigation of the simple pendulum (in classroom).

4. Library research and written report on assigned topics (in conjunction with the English curriculum).

IV. Units of instruction

One of the purposes of the science program was to emphasize the unity and inter-relationship of all of the scientific disciplines. The instructional materials were chosen, wherever possible, with this criterion in mind. Consequently, it was not intended that the science material be subdivided into specific units. The general scientific topics studied in the program can, however, be categorized under the following general headings:

A. Physics
B. Chemistry
C. Astronomy
D. Earth Science
E. Biology
F. Electronics
G. Computer application

The following tabulation indicates the inclusion of these general topics in each of the published instructional instruments used:

	Physics	Chemistry	Astronomy	Earth Science	Biology	Electronics	Computer Application
One, Two, Three...Infinity	X	X	X	X	X		
Understanding Chemistry	X	X		X			
Earth, Sea and Air	X		X	X			
The Dawn of Life	X	X		X	X		
Electronics in Everyday Things	X					X	
Computers						X	X
Science News	X	X	X	X	X	X	X

Addendum No. 1. Science Curriculum Guide

Chapter 3: Understanding Chemistry, Lessing

1. How does the abundancy of a raw material affect production of goods?
2. List 9 common elements. Give their chemical symbols.
3. Name several sources of hydrocarbons.
4. Why is table salt said to be composed of 23 pts. by wt. of sodium and 35 pts. by weight of chlorine?
5. What is the Solvay process?
6. How does Nitrogen occur in the atmosphere?
7. Note how an explosion occurs.
8. How would you write the formula for ammonium?
9. What is a catalyst? How does a catalyst enter in the Haber process?
10. How does coal become a raw material for the chemist?
11. Identify a few peculiar properties of carbon.
12. What is distillation? How is fractional distillation used in the oil industry? Explain in terms of molecules.
13. Write the formula for methane.
14. How would you write propane?
15. What is meant by a carbon chain?
16. What do the following mean? H ce, $H_2 SO_4$, Na OH, H OH, NaCe, Au.

Earth, Sea and Air, Spar

January 5, 1967

Study Guide (No. 1)

Chapter 1, Part 1 (You will note that much of the detail has been omitted.)

1. How does one account for the high heat found below the surface of the earth?

2. How is a stable, nonradioactive isotope different from a radioactive isotope? What is a *parent*, *daughter products*?

3. Approximately how old is the earth? What kind of evidence is there to support this assumption? How does *half-life* enter into the picture?

4. Why do scientists today favor the condensation or compaction theory first proposed by Kant in 1755? How does the interpretation of this theory affect your thinking about the destiny of the earth?

5. What composes the Solar System?

6. Note how the geocentric theory gave way to the heliocentric theory. The Copernican theory left some questions. Now did Kepler resolve the problem? What is the importance of Newton's findings?

7. See page 10 to help you better understand Kepler's laws.

8. Distinguish between gravitational and centrifugal.

9. What is sidereal time? How long is a sidereal month? The sun completes one rotation about its axis relative to the stars every ______ days.

10. Why does the same side of the moon always face the earth?

11. How long is a synodic month? What is it? How much longer is it than the sidereal month?

12. What is a lunar eclipse? A solar eclipse? Solar time?

13. How does the sundial work?

14. What is the international date line?

15. ______ degrees of longitude equal one hour of clock time.

16. The reason for seasonal variation in terms of sun "rising and setting" and daylength is the ____________.

17. Read the bottom of page 20 and page 21.

Study Guide (No. 2)

Chapter 1, pp. 21-40

1. Briefly list the several shapes the earth has been theorized to have. What is the final form of all the listed shapes? How was this found to be so?

2. What is longitude? Latitude? How does direction fit in when measuring longitude and latitude?

3. Note we will not attempt to compute longitude or latitude.

4. What causes differences in gravity over the surface of the earth? How does this affect the weight of an object? Where does weight decrease? Where do objects weigh more?

5. Why don't the oceans "roll downhill"? Why does a pendulum clock "run slow" at the equator?

6. What is a map?

A. Distinguish between:

   1. Ptolemaic theory and Copernician theories

   2. aphelion and perihelion

   3. rotation and revolution

   4. geodesy and physiographic

   5. latitude and longitude

   6. ecosphere and lithosphere

7. synodic and sidereal months

8. international date line and Greenwich Meridian

9. apogee and perigee

10. catastrophism and uniformitarianism

11. deep and trough

12. refraction and reflection

13. declination and inclination

14. intrusive and extrusive

15. metamorphic, sedimentary and igneous rocks

16. spring tide and neap tide

17. thermocline and anticline

18. troposphere and ionosphere

19. cyclone and anticyclone

20. barometer and bathymeter

B. You will be responsible for the spelling of all the terms in the four vocabulary lists from Spar.

C. Bring your maps of the Boulder Quadrangle and your metric rulers.

D. Bring Spar. I am considering using the book for the interpretation of several of the following diagrams, e.g.:

p. 127; p. 126; p. 120; p. 121; p. 103; p. 70; p. 34; Fig. 5, p. 12

The first test over this material will be April 8, 1967.

Earth, Sea and Air, Spar
Study Guide

Chapter II., Set 1

1. What was Cuvier's important contribution to science?

2. Give several evidences for the support of uniformitarianism---even today.

3. How is the study of rock strata important to man today?

4. Examine the chart on page 44. Learn to recognize the terms. Can you spell all of them? Please observe that each term is capitalized. About how old are the rocks in which algae have been found.

5. Which are older - The Rockies or Appalachians? If you look at the "lay of the land," how can you distinguish the younger mountains from the older mountains? Read at least to page 49 before you answer this question.

6. Can you cite some examples of diastrophism? Read to page 49.

7. What are the several theories of continental development? Which theory is supported by a great number of geologists? Can you suggest why this is so?

8. Briefly, how does the crust of the earth vary over the surface of the earth? How can you account for the differences?

9. Distinguish between: basin, deep, trough.

10. What types of activities, in time, have affected the appearance of the crust of the earth? Can you picture in your mind how such processes might occur?

11. What is the difference between the refraction and reflection of a p-wave?

12. Note the chart on p. 57.

13. What is the difference between the Mercalli and Richter scale?

14. What is meant by magnetic declination? What is the declination of Boulder? Ask a friend who knows.

15. What is meant by inclination?

Addendum No. 2. Science Curriculum Guide

(sample vocabulary and terminology lists)

Terms to learn to spell and recognize from Chapter I.

geophysics
geodesy
nebula, nebulus
daughter products
geocentric
ptolemaic theory
universe
heliocentric
ellipse
foci
eccentricity
perihelion
aphelion
ecliptic
chronometer
cartographer

apogee
perigee
synodic
solstice
equinox
longitude
latitude
Greenwich Civil Time (GCT)
sidereal
photogrammetry
geoid
geodesic
centrifugal
centripetal
isostasy
torsion

Spar -- Terms to learn to spell and recognize from Chapter III.

heat of vaporization
latent heat of condensation
heat of fusion
latent heat of fusion
hydrologic cycle
sill
oceanographic
sonar
fathom
salinity
thermocline
bathythermograph
insolation

abedo
drogue
dynamo
upwelling
storm surge
Coriolis force (see p. 109)
seiches
tsunamis
fetch
diurnal
spring tide
neap tide
gyre

Questions

1. Why is the ocean blue? Why is it green in places?
2. If 5 meters per second equals 10 knots, how many miles per hour are equal to 10 knots?
3. Study charts pp. 70, 86, 87.

Part II. Identify the following terms by definition

1. Ptolemaic Theory and Copernican Theory
2. rotation and revolution
3. latitude and longitude
4. ecosphere and lithosphere
5. international date line and Greenwich Meridian
6. apogee and perigee
7. catastrophism and uniformitarianism
8. deep and trough
9. refraction and reflection
10. intrusive and extrusive
11. thermocline and anticline
12. troposphere and ionosphere
13. cyclone and anticyclone
14. barometer and thermometer
15. geography and geology

Spar -- Terms to learn to spell and recognize from Chapter II.

lithosphere
geophysicist
catastrophism
uniformitarianism
primeval
stratigraphy
vulcanism
stratum (strata)
intrusive
extrusive
tectonic
diastrophism
orogenetic
Moho
ferro - magnesian
igneous
metamorphic
sedimentary
fathom
glosyncline
schist
gneiss
peneplain
seismic
moraine
dipole
declination
inclination

Mohorovicic discontinuity
mantle
sial
basalt
magnetogram
geomagnetic
aurora

Spar -- Terms -- Chapter IV.

1. ozone
2. aerosol
3. psychrometer
4. radiosonde
5. troposphere
6. stratosphere
7. ionosphere
8. barometer
9. millibar
10. aneroid
11. bathymeter
12. cyclone
13. anticyclone
14. hydrostatic
15. periphery
16. doldrum
17. monsoon
18. anticyclonically
19. orographic
20. cumulus
21. solstice
22. radiocarbon

Questions:

1. Be prepared to discuss several aspects of pollution and the effects of pollution upon the ecosphere.

2. Examine carefully the chart on page 105, also, the chart on page 113 should be studied.

3. Note the diagram on page 127.

Addendum No. 3. Science Curriculum Guide
(sample examinations and short quizzes)

Part III

A. With your Boulder Quadrangle Map and your metric rulers, locate the following in degrees, minutes, seconds of latitude and longitude.

1. The center of Allen's Lake.

2. Longmont power plant (near Steamboat Mountain).

B. Interpret the following diagrams to the best of your ability. The text explanation will not be acceptable. (from Spar)

1. P. 127.

2. P. 103 or Fig. 5, P. 12.

I. Matching: Match the term in the left column to the proper phrase or term in the right column. Use a term only once.

a. autotroph
b. ATP
c. basalt
d. carbonate
e. catalyst
f. replication
g. chromatin
h. dextrose
i. anaerobic
j. heterotroph
k. sulphide
l. ion
m. rotation
n. revolution
o. mutation
p. nitrate
q. quantum
r. RNA
s. aerobic
t. evolution
u. gravitation

____1. enzyme
____2. permanent, hereditary change
____3. a simple sugar
____4. eats other organisms
____5. ___ CO_3
____6. ___ NO_3
____7. manufactures own food
____8. H_2S
____9. Substance resulting from volcanic activity
____10. energy-rich compound
____11. particle of light
____12. movement around a body
____13. charged atom
____14. copying process
____15. without oxygen
____16. growth of ideas
____17. grows in oxygen
____18. movement on own axis
____19. Part of this word means color
____20. involved in protein synthesis

II. Correct the following misspelled words. To the right of any misspelled words, write the correct form of the word.

asturoid ______________________ 21.
billiard ______________________ 22.
butyric ______________________ 23.
chlorophyl ______________________ 24.
coacervate ______________________ 25.
cisteine ______________________ 26.
duterium ______________________ 27.
gravitational ______________________ 28.
kinetic ______________________ 29.
galaxys ______________________ 30.
hemoglobin ______________________ 31.
hydrolisis ______________________ 32.
isomeric ______________________ 33.
meteor ______________________ 34.
symetry ______________________ 35.
ozone ______________________ 36.
planetary ______________________ 37.
planetecimal ______________________ 38.
porphyrin ______________________ 39.
pyridine ______________________ 40.

III. 10 Points. Discussion. What are the ecological necessities of an organism. Underscore each necessity discussed.

IV. Discuss what effect or effects ultra violet has had upon evolution.

V. 25 Points. What is pollution? What types of pollution are there? What types of substances enter into the pollution problem? Why is the elimination of pollution important to man and other organisms in the ecosphere?

Discussion:

1. In a certain city, 1 girl in 3 is blond, 1 girl in 4 is slim, and 1 girl in 10 is wealthy. The number of boys and girls living in the city is equal. What are the chances that the first person you see in the city will be a wealthy, slim, blond girl?

2. The chances of drawing a king from a full deck of cards?

3. The chances of drawing a king of spades from a full deck of cards?

4. The chances of drawing 3 aces in succession from a full deck of cards?

5. If you flip 3 coins at once, what are the chances that all three will land heads up? All three tails? 2 heads and 1 tail? 2 tails and 1 head?

6. A family has 5 boys in a row. Another child is expected within the week. What are the chances of it being a boy?

7. If there is one chance in 3000 of catching polio and one chance in 6000 of catching TB, what are the chances of catching polio and TB at the same time?

Part 1 - Terms for Spelling. To be read.

1. homogenous
2. homogeneous
3. heterogenous
4. heterogeneous
5. molecule
6. lattice
7. solar
8. trajectory
9. datum, data
10. deuterium
11. hexa methyl benzene
12. ameba
13. metastibility
14. neutron
15. calorie
16. thermal
17. Kelvin
18. chromatin
19. chromosome
20. syngamy
21. gamete
22. osmosis
23. meiotic
24. somatic
25. mitotic
26. deoxyribonucleic acid
27. purine
28. pyrimidine
29. helix
30. autotrophic
31. epithelial
32. heterotrophic
33. laser
34. maser
35. parallax
36. Galaxy
37. Doppler effect
38. hypothesis